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PATENT ABSTRACTS OF JAPAN

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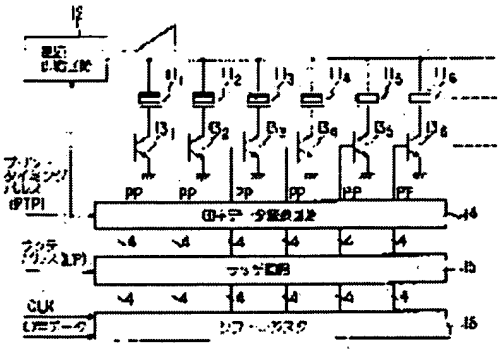
(54) DRIVING OF RECORDING HEAD

(57)Abstract:

PROBLEM TO BE SOLVED: To perform gradation printing by making the ink emitting amt. from an ink chamber variable by simple control.

SOLUTION: A reference voltage waveform of a triangle wave is outputted from a power supply circuit 12 to be applied to a piezoelectric member 11i. The transistor 13i corresponding to the piezoelectric member desired to be driven is subjected to ONoperation simultaneously with the application of the reference voltage waveform to the piezoelectric member. By this constitution, an ink chamber is opened. Thereafter, immediately before the reference voltage waveform falls to earth potential steeply, the transistor is once subjected to OFF-operation. By this mechanism, the piezoelectric member holds charge to hold its displacing position. At this time, the supply of ink to the ink chamber is performed. After the elpse of a proper holding time, the transistor is again subjected to ON-operation to return the piezoelectric member to a steady state. By this constitution, the ink chamber returns to the original state suddenly and ink is emitted from the ink chamber. The ink emitting amt. at this time is made variable by making the holding time variable and gradation printing can be performed.



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DETAILED DESCRIPTION

[Detailed Description of the Invention]
[0001]
[Field of the Invention] This invention relates to the drive approach of the recording head which carries out the regurgitation of the ink from an ink room according to deformation of a piezo-electric member.
[0002]
[Description of the Prior Art] As the drive approach of this kind of recording head, the thing of JP,2-164544,A is known, for example. It connected with the output terminal of the current supply circuit 2 by having used the electrode as the common electrode, and this has grounded the electrode of another side through NPN transistor 31, 32, 33, 34, 35, 36, and --, respectively, as while connecting with the piezo-electric member 11, 12, 13, 14, 15, 16, and -- shows drawing 17 . And when driving the piezo-electric member 11, 12, 13, 14, 15, 16, and --, a transistor 31, 32, 33, 34, 35, 36, and -- are made into an ON state, and a constant current input is performed to each piezo-electric member from the output terminal of the current supply circuit 2. That is, he impresses a driver voltage wave to the common electrode of each piezo-electric member from the output terminal of the current supply circuit 2, and is trying to make ink breathe out from the ink delivery of the ink room which chooses the piezo-electric member which drives a transistor 31, 32, 33, 34, 35, 36, and -- by carrying out ON actuation alternatively, and corresponds.
[0003]
[Problem(s) to be Solved by the Invention] Since this conventional drive approach performs only control which chooses the piezo-electric member driven by a transistor 31, 32, 33, 34, 35, 36, and --, it was not able to carry out adjustable [of the discharge quantity of ink], and was not able to perform gradation printing.
[0004] Then, invention according to claim 1 to 6 offers the drive approach of the recording head which can carry out adjustable control of the discharge quantity of the ink from an ink room in easy control, and can perform gradation printing.
[0005]
[Means for Solving the Problem] In the recording head which invention according to claim 1 impresses an electrical potential difference to a piezo-electric member, makes carry out the variation rate of this piezo-electric member, makes transform an ink room with the variation rate of this piezo-electric member, and performs discharge printing for the ink of this ink interior of a room Impress a reference voltage wave for every printing timing to a piezo-electric member, hold the impression condition of an electrical potential difference over a piezo-electric member in the impression period of this reference voltage wave, and the displacement condition of this piezo-electric member is held. It is in carrying out adjustable [of the discharge quantity of ink] by changing the holding time at this time, and performing gradation printing.
[0006] In the recording head which invention according to claim 2 impresses an electrical potential difference to a piezo-electric member, makes carry out the variation rate of this piezo-electric member, makes transform an ink room with the variation rate of this piezo-electric member, and performs discharge printing for the ink of this ink interior of a room Carry out ON actuation of the switching element, and the electrode of another side connected to a piezo-electric member while while connecting with a piezo-electric member impresses a reference voltage wave for every printing timing to an electrode is grounded. In the impression period of a reference voltage wave over a piezo-electric member, carry out off actuation of the switching element, hold the impression condition of an electrical potential difference over a piezo-electric member, and the displacement condition of this piezo-electric member is held. It is in changing the holding time by changing the ON actuation timing of a subsequent switching element, carrying out adjustable [of the discharge quantity of ink], and performing gradation printing.
[0007] In the recording head which invention according to claim 3 impresses an electrical potential difference to a piezo-electric member, makes carry out the variation rate of this piezo-electric member, makes transform an ink room with the variation rate of this piezo-electric member, and performs discharge printing for the ink of this ink interior of a room The

reference voltage wave from which a voltage level changes to a piezo-electric member is impressed for every printing timing. It is in holding the impression condition of an electrical potential difference over a piezo-electric member in the impression period of this reference voltage wave, holding the displacement condition of this piezo-electric member, carrying out adjustable [of the discharge quantity of ink] by changing the maintenance electrical potential difference at this time, and performing gradation printing.

[0008] In the recording head which invention according to claim 4 impresses an electrical potential difference to a piezo-electric member, makes carry out the variation rate of this piezo-electric member, makes transform an ink room with the variation rate of this piezo-electric member, and performs discharge printing for the ink of this ink interior of a room Carry out ON actuation of the switching element, and the electrode of another side connected to a piezo-electric member while impressing the reference voltage wave from which a voltage level changes to an electrode in while connecting with a piezo-electric member for every printing timing is grounded. In the impression period of a reference voltage wave over a piezo-electric member, carry out off actuation of the switching element, hold the impression condition of an electrical potential difference over a piezo-electric member, and the displacement condition of this piezo-electric member is held. It is in changing the maintenance electrical potential difference to a piezo-electric member by changing the off actuation timing of the switching element at this time, carrying out adjustable [of the discharge quantity of ink], and performing gradation printing.

[0009] In the recording head which invention according to claim 5 impresses an electrical potential difference to a piezo-electric member, makes carry out the variation rate of this piezo-electric member, makes transform an ink room with the variation rate of this piezo-electric member, and performs discharge printing for the ink of this ink interior of a room Carry out ON actuation of the switching element, and the electrode of another side connected to a piezo-electric member while impressing the reference voltage wave from which a voltage level changes to an electrode in while connecting with a piezo-electric member for every printing timing is grounded. In the impression period of a reference voltage wave over a piezo-electric member, carry out off actuation of the switching element, hold the impression condition of an electrical potential difference over a piezo-electric member, and the displacement condition of this piezo-electric member is held. The holding time is changed by changing the maintenance electrical potential difference to a piezo-electric member by changing the off actuation timing of the switching element at this time, and changing the ON actuation timing of a subsequent switching element. By this It is in carrying out adjustable [of the discharge quantity of ink], and performing gradation printing.

[0010] In the recording head which invention according to claim 6 impresses an electrical potential difference to a piezo-electric member, makes carry out the variation rate of this piezo-electric member, makes transform an ink room with the variation rate of this piezo-electric member, and performs discharge printing for the ink of this ink interior of a room Two or more sorts of reference voltage waves corresponding to each gradation printing while connecting with a piezo-electric member are continuously impressed for every printing timing to an electrode. It is in carrying out adjustable [of the discharge quantity of ink] by choosing the reference voltage wave which controls the timing when carrying out ON actuation of the switching element, and grounding the electrode of another side linked to a piezo-electric member, and is impressed to each inter-electrode one of a piezo-electric member, and performing gradation printing.

[0011]

[Embodiment of the Invention] Hereafter, the gestalt of operation of this invention is explained with reference to a drawing.

(Gestalt of the 1st operation) The gestalt of this operation describes the gestalt of the operation corresponding to claims 1 and 2. As shown in drawing 1 , two or more piezo-electric members 111, 112, 113, 114, 115,116, and -- were prepared, and while connecting with each of this piezo-electric member 111-116 and -- is connected to the output terminal of the current supply circuit 12 by using an electrode as a common electrode. The electrode of another side linked to said each piezo-electric member 111-116 and -- is grounded respectively through NPN transistor 131, 132, 133, 134, 135, 136, and --.

[0012] Said each transistor 131-136 and the base of -- are connected to the printing data-conversion circuit 14, and the print pulse signal PP is impressed from the printing data-conversion circuit 14 to this base. It connected with the latch circuit 15 and said latch circuit 15 has connected said printing data-conversion circuit 14 to a shift register 16.

[0013] If this drive circuit carries out a sequential shift, stores the printing data of 16 gradation (4 bits) in said shift register 16 synchronizing with Clock CLK and stores each piezo-electric member 111-116 and the printing data corresponding to -- in said shift register 16, by the input of the latch pulse LP, it will be latched to said latch circuit 15, and will be inputted into said printing data-conversion circuit 14. Said printing data-conversion circuit 14 changes said each transistor 131-136 and -- into ON and the print pulse PP for carrying out off actuation for the inputted printing data. Said current supply circuit 12 impresses the reference voltage wave with each piezo-electric member 111-116, the start with -- smooth to a common electrode, and a ****** fall of a triangular wave for every printing timing.

[0014] Here, a printing principle is described using the mimetic diagram shown in drawing 3 . First, at a steady state, it

is (d) of drawing 3 . Piezo-electric member 11i (i= 1, 2 and 3, --) did not displace, but ink is [i] full of the ink room 17 so that it may be shown. Transistor 13i (i= 1, 2 and 3, --) is turned ON in this condition, and it is piezo-electric member 11i from the current supply circuit 12. If a reference voltage wave is impressed, it is piezo-electric member 11i by the smooth start first. It displaces so that the ink room 17 may be opened. At this time, the ink regurgitation side 18 of ink, i.e., a meniscus, is (a) of drawing 3 . It retreats to the ink room 17 side so that it may be shown.
[0015] It is piezo-electric member 11i immediately in this condition. It is [******** and] piezo-electric member 11i to touch-down potential in **** about the reference voltage wave to impress. (d) of drawing 3 Although it returns to the shown steady state, since a supplement of the ink to the ink room 17 is hardly performed at this time, there is little discharge quantity of the ink from the ink room 17. That is, it becomes low printing of gradation concentration.
[0016] Moreover, (a) of drawing 3 When it holds for a while after the meniscus 18 has retreated to the ink room 17 side so that it may be shown, a supplement of the ink to the ink room 17 is performed, and a meniscus 18 is (b) of drawing 3 . It comes to return to an ink regurgitation side so that it may be shown. Therefore, it is piezo-electric member 11i in this condition. It is [******** and] piezo-electric member 11i to touch-down potential in **** about the reference voltage wave to impress. (d) of drawing 3 Although it returns to the shown steady state, since the supplement of the ink to the ink room 17 is performed to some extent at this time, the discharge quantity of the ink from the ink room 17 increases a little. That is, gradation concentration serves as printing which is whenever [middle].
[0017] Moreover, (a) of drawing 3 When it holds for a long time after the meniscus 18 has retreated to the ink room 17 side so that it may be shown, a supplement of the ink to the ink room 17 is fully performed, and a meniscus 18 is (c) of drawing 3 . It comes to return completely to an ink regurgitation side so that it may be shown. Therefore, it is piezo-electric member 11i in this condition. It is [******** and] piezo-electric member 11i to touch-down potential in **** about the reference voltage wave to impress. (d) of drawing 3 Although it returns to the shown steady state, since the supplement of the ink to the ink room 17 is fully performed at this time, the discharge quantity of the ink from the ink room 17 increases. That is, it becomes high printing of gradation concentration. In this way, the discharge quantity of ink can be adjusted by deciding ink regurgitation timing with the return location of the meniscus which retreated, and gradation printing is attained.
[0018] Then, when it becomes printing timing in the drive circuit of drawing 1 , it is (a) of drawing 2 . The print timing pulse PTP is supplied to the current supply circuit 12 and the printing data-conversion circuit 14 so that it may be shown, and it is (b) of drawing 2 from the current supply circuit 12. A reference voltage wave as shown is outputted. Moreover, piezo-electric member 11i to drive Corresponding transistor 13i To the base, it is (c) of drawing 2 . The print pulse PP as shown is supplied. Namely, piezo-electric member 11i It is transistor 13i to impression of a reference voltage wave, and coincidence. Just before it carries out ON actuation and a reference voltage wave falls to touch-down potential at ****, it is transistor 13i. Off actuation is once carried out. Piezo-electric member 11i The displacement location will be held [holding a charge, even if transistor 13i turns off, since it is volume load, and].
[0019] then, comparatively long in this condition -- since time amount maintenance is carried out -- transistor 13i carrying out ON actuation again -- piezo-electric member 11i a charge -- rapid -- discharging -- piezo-electric member 11i It returns to a steady state. In this way, piezo-electric member 11i The voltage waveform supplied is (d) of drawing 2 . It comes to be shown and the amount of ink which carries out the regurgitation from an ink room to the timing to which this voltage waveform falls increases. That is, it becomes high printing of gradation concentration.
[0020] Moreover, transistor 13i About the print pulse PP impressed to the base, it is (e) of drawing 2 . If it is made to change so that it may be shown, it is piezo-electric member 11i. The period holding a charge becomes short a little, and is piezo-electric member 11i at this time. The voltage waveform supplied is (f) of drawing 2 . It comes to be shown and the amount of ink which carries out the regurgitation from an ink room to the timing to which this voltage waveform falls decreases a little. That is, gradation concentration serves as printing which is whenever [middle].
[0021] Moreover, transistor 13i About the print pulse PP impressed to the base, it is (g) of drawing 2 . If it is made to change so that it may be shown, it is piezo-electric member 11i. The period holding a charge becomes still shorter and is piezo-electric member 11i at this time. The voltage waveform supplied is (h) of drawing 2 . It comes to be shown and the amount of ink which carries out the regurgitation from an ink room to the timing to which this voltage waveform falls decreases. That is, it becomes low printing of gradation concentration.
[0022] Thus, transistor 13i The print pulse PP impressed to the base is changed, and it is piezo-electric member 11i. By easy control which carries out adjustable [of the period holding a charge], the amount of ink which carries out the regurgitation from an ink room can be adjusted, and gradation printing can be performed.
[0023] As a recording head used for such control, there is a recording head of the kayser method shown in drawing 4 , for example. This recording head constitutes the top face of the ink room 21 from an elastic plate 22, on this elastic plate 22, forms electrodes 24 and 25 in both sides, and is fixing the piezo-electric member 23. And the ink feed hopper 27 is formed in the opposite side of the ink delivery 26, and the ink to the ink interior of a room is filled up.
[0024] This recording head is (a) of drawing 4 . When the voltage waveform of a triangular wave is impressed to the

piezo-electric member 23 in the shown steady state, in the start with a smooth electrical potential difference, the piezo-electric member 23 is contracted in the direction of a field according to the piezo-electric transversal effect, the bending moment occurs by the equilibrium of stress with an elastic plate 22, and an elastic plate 22 is (b) of drawing 4 . It deforms in the direction which expands the volume of the ink room 21 so that it may be shown. And where the piezo-electric member 23 is displaced, after carrying out fixed time amount maintenance, ******** and the piezo-electric member 23 are (c) of drawing 4 to **** about applied voltage. It returns to a steady state so that it may be shown, and the volume of the ink room 21 returns by this, and ink carries out the regurgitation from the ink delivery 26.

[0025] (Gestalt of the 2nd operation) The gestalt of this operation describes the gestalt of the operation corresponding to claims 1 and 2. The configuration of the drive circuit of the gestalt of this operation is the same as that of the gestalt of the 1st operation fundamentally. A different point is a point of having changed each piezo-electric member 111-116 and the reference voltage wave of -- impressed to one electrode from the current supply circuit 12.

[0026] That is, as timing of operation is shown in drawing 5 and a printing principle is typically shown in drawing 6 , it sets in the gestalt of this operation, and it is (a) of drawing 5 . Each piezo-electric member 111-116 and the reference voltage wave of -- impressed to one electrode output from the current supply circuit 12 by the shown print timing pulse PTP. This reference voltage wave is (b) of drawing 5 . It falls to electronegative potential at **** so that it may be shown, and it has become the square wave which starts after fixed time amount at ****.

[0027] By impressing such a reference voltage wave, it is (c) of drawing 5 . The shown printer pulse PP is transistor 13i. If it impresses, it is piezo-electric member 11i. (d) of drawing 6 It displaces in the direction which extrudes the ink in the ink room 17 from the shown steady state. And it sets, just before a reference voltage wave starts, and it is transistor 13i. Off actuation is carried out and it is piezo-electric member 11i. A displacement condition is held. After continuing this maintenance condition comparatively long, it is transistor 13i. ON actuation is carried out again and it is piezo-electric member 11i. It is made to return to a steady state. By this control, it is piezo-electric member 11i. A supply voltage wave is (d) of drawing 5 . It comes to be shown and the ink in the ink room 17 is piezo-electric member 11i comparatively long. Since a variation rate extrudes, at this time, it is (c) of drawing 6 . The discharge quantity of ink increases so that it may be shown.

[0028] Moreover, (e) of drawing 5 The shown printer pulse PP is transistor 13i. If it impresses, it is piezo-electric member 11i. (d) of drawing 6 It displaces in the direction which extrudes the ink in the ink room 17 from the shown steady state. And it sets, just before a reference voltage wave starts, and it is transistor 13i. Off actuation is carried out and it is piezo-electric member 11i. Although a displacement condition is held, before a maintenance condition continues not much long shortly, it is transistor 13i. ON actuation is carried out again and it is piezo-electric member 11i. It is made to return to a steady state. By this control, it is piezo-electric member 11i. A supply voltage wave is (f) of drawing 5 . It comes to be shown and the ink in the ink room 17 is piezo-electric member 11i. The period extruded by the variation rate becomes short a little. Therefore, at this time, it is (b) of drawing 6 . The discharge quantity of ink becomes whenever [middle] so that it may be shown.

[0029] Moreover, (g) of drawing 5 The shown printer pulse PP is transistor 13i. If it impresses, it is piezo-electric member 11i. (d) of drawing 6 It displaces in the direction which extrudes the ink in the ink room 17 from the shown steady state. And it sets, just before a reference voltage wave starts, and it is transistor 13i. Off actuation is carried out and it is piezo-electric member 11i. Although a displacement condition is held, while a maintenance condition hardly continues shortly, it is transistor 13i. ON actuation is carried out again and it is piezo-electric member 11i. It is made to return to a steady state. By this control, it is piezo-electric member 11i. A supply voltage wave is (h) of drawing 5 . It comes to be shown and the ink in the ink room 17 is piezo-electric member 11i. The period extruded by the variation rate becomes still shorter. Therefore, at this time, it is (a) of drawing 6 . The discharge quantity of ink decreases so that it may be shown.

[0030] Thus, piezo-electric member 11i Even if it is the case where a variation rate is made to carry out in the direction which extrudes the ink in the ink room 17, it is piezo-electric member 11i. By easy control which carries out adjustable [of the period which holds a charge and holds a displacement condition], the amount of ink which carries out the regurgitation from an ink room can be adjusted, and gradation printing can be performed.

[0031] (Gestalt of the 3rd operation) The gestalt of this operation describes the gestalt of the operation corresponding to claims 3 and 4. The configuration of the drive circuit of the gestalt of this operation is the same as that of the gestalt of the 1st operation fundamentally. A different point is a point of having changed each transistor 131-136 and the print pulse PP of -- impressed to the base from the printing data-conversion circuit 14.

[0032] That is, as timing of operation is shown in drawing 7 and a printing principle is typically shown in drawing 8 , it sets in the gestalt of this operation, and it is (a) of drawing 7 . It is (b) of the current supply circuit 12 to drawing 7 at the supply timing of the shown print timing pulse PTP. The reference voltage wave of a triangular wave as shown is outputted. Moreover, piezo-electric member 11i to drive Corresponding transistor 13i To the base, it is (c) of drawing 7 . The print pulse PP as shown is supplied. Namely, piezo-electric member 11i It is transistor 13i to impression of a

reference voltage wave, and coincidence. Just before it carries out ON actuation and a reference voltage wave falls to touch-down potential at ****, it is transistor 13i. Off actuation is once carried out. Thereby, it is piezo-electric member 11i. A charge is held where an electrical potential difference V1 is impressed. Namely, piezo-electric member 11i (d) of drawing 8 (a) of the shown steady state to drawing 8 It holds in the condition of having displaced greatly so that it might be shown.

[0033] Then, after carrying out fixed time amount maintenance of this condition, it is transistor 13i. It is piezo-electric member 11i by carrying out ON actuation again. A charge discharges rapidly and is piezo-electric member 11i. (d) of drawing 8 It returns to the shown steady state. Namely, piezo-electric member 11i The voltage waveform supplied is (d) of drawing 7 . It comes to be shown. Thus, piezo-electric member 11i Comparatively high electrical potential difference V1 It is piezo-electric member 11i by making it hold in the condition of having impressed. The amount of displacement when returning to a steady state is enlarged, and, thereby, the amount of ink which carries out the regurgitation from an ink room increases. That is, it becomes high printing of gradation concentration.

[0034] Moreover, piezo-electric member 11i to drive Corresponding transistor 13i To the base, it is (e) of drawing 7 . The print pulse PP as shown is supplied. Namely, piezo-electric member 11i It is transistor 13i to impression of a reference voltage wave, and coincidence. It is transistor 13i at the second half when ON actuation was carried out and the reference voltage wave has started smoothly. OFF actuation is once carried out. Thereby, it is piezo-electric member 11i. A charge is held where an electrical potential difference V2 (<V1) is impressed. Namely, piezo-electric member 11i (d) of drawing 8 (b) of the shown steady state to drawing 8 It holds in the condition of having displaced to whenever [middle] so that it might be shown.

[0035] Then, after carrying out fixed time amount maintenance of this condition, it is transistor 13i. It is piezo-electric member 11i by carrying out ON actuation again. A charge discharges rapidly and is piezo-electric member 11i. It returns to the steady state shown in (d) of drawing 8 . Namely, piezo-electric member 11i The voltage waveform supplied is (f) of drawing 7 . It comes to be shown. Thus, piezo-electric member 11i Electrical potential difference V2 of whenever [middle] It is piezo-electric member 11i by making it hold in the condition of having impressed. The amount of displacement when returning to a steady state is made whenever [middle], and this controls the amount of ink which carries out the regurgitation from an ink room to whenever [middle]. That is, gradation concentration serves as printing which is whenever [middle].

[0036] Moreover, piezo-electric member 11i to drive Corresponding transistor 13i To the base, it is (g) of drawing 7 . The print pulse PP as shown is supplied. Namely, piezo-electric member 11i It is transistor 13i to impression of a reference voltage wave, and coincidence. It is transistor 13i at the first half when ON actuation was carried out and the reference voltage wave has started smoothly. OFF actuation is once carried out. Thereby, it is piezo-electric member 11i. A charge is held where an electrical potential difference V3 (<V2) is impressed. Namely, piezo-electric member 11i (d) of drawing 8 (c) of the shown steady state to drawing 8 It holds in the condition of not displacing so much so that it may be shown.

[0037] Then, after carrying out fixed time amount maintenance of this condition, it is transistor 13i. It is piezo-electric member 11i by carrying out ON actuation again. A charge discharges rapidly and is piezo-electric member 11i. It returns to the steady state shown in (d) of drawing 8 . Namely, piezo-electric member 11i The voltage waveform supplied is (h) of drawing 7 . It comes to be shown. Thus, piezo-electric member 11i Comparatively low electrical potential difference V3 It is piezo-electric member 11i by making it hold in the condition of having impressed. The amount of displacement when returning to a steady state is made small, and, thereby, the amount of ink which carries out the regurgitation from an ink room is lessened. That is, it becomes low printing of gradation concentration. Thus, piezo-electric member 11i By easy control which carries out adjustable [of the voltage level when holding a charge], the amount of ink which carries out the regurgitation from an ink room can be adjusted, and gradation printing can be performed.

[0038] In addition, at the gestalt of this operation, it is piezo-electric member 11i. Although adjustable [of the voltage level when holding a charge] is carried out and the amount of ink was adjusted, it is piezo-electric member 11i further to this. If the holding time when holding a charge is considered and the amount of ink is adjusted by both the electrical potential difference and the holding time, finer gradation control will be attained. In order to realize this, it is (c) of drawing 7 . (e) (g) It sets and is transistor 13i. Pulse P1 of the print pulse PP which carries out ON actuation again What is necessary is just to change generating timing.

[0039] (Gestalt of the 4th operation) The gestalt of this operation describes the gestalt of the operation corresponding to claim 6. The configuration of the drive circuit of the gestalt of this operation is the same as that of the gestalt of the 1st operation fundamentally, as shown in drawing 9 , and different points are the current supply circuit 32 and the printing data-conversion circuit 34 which outputs the print pulse PP. That is, said current supply circuit 32 outputs continuously various kinds of reference voltage waves from which a wave differs for every printing timing. For example, reference voltage wave T1 of a triangular wave And reference voltage wave T2 of the trapezoidal shape which is two kinds from which the die length of a constant-voltage period differs and T3 Three kinds are outputted continuously.

Each of each reference voltage waves is waves ****** [standup] in smoothness and a fall.
[0040] Said printing data-conversion circuit 34 is three kinds of reference voltage wave T1, T2, and T3. In order to choose any are made to impress to each piezo-electric member 111-116 and --, each transistor 131-136 and the print pulse PP which carries out ON actuation of -- are generated.
[0041] When it becomes printing timing in this drive circuit, it is (a) of drawing 10 . Supplying the print timing pulse PTP to the current supply circuit 32 and the printing data-conversion circuit 34 so that it may be shown, thereby, the current supply circuit 32 is (b) of drawing 10 . Three kinds of reference voltage wave T1 as shown, T2, and T3 It outputs continuously. Moreover, piezo-electric member 11i to drive Corresponding transistor 13i To the base, it is (c) of drawing 10 . It is reference voltage wave T3 so that it may be shown. The print pulse PP for choosing is supplied.
[0042] thereby -- piezo-electric member 11i **** -- (d) of drawing 10 A supply voltage wave as shown will impress. This supply voltage wave is piezo-electric member 11i. Fixed time amount maintenance of the charge is carried out, and it is piezo-electric member 11i. Fixed time amount maintenance is carried out in a predetermined displacement location. And it is piezo-electric member 11i after fixed time amount progress. A charge is discharged rapidly and it is piezo-electric member 11i. It returns to a steady state. In this way, piezo-electric member 11i The amount of ink which carries out the regurgitation from an ink room by supplying the voltage waveform which carries out fixed time amount maintenance in a predetermined displacement location increases. That is, it becomes high printing of gradation concentration.
[0043] Moreover, piezo-electric member 11i to drive Corresponding transistor 13i To the base, it is (e) of drawing 10 . It is reference voltage wave T2 so that it may be shown. The print pulse PP for choosing is supplied. thereby -- piezo-electric member 11i **** -- (f) of drawing 10 A supply voltage wave as shown will impress. This supply voltage wave is piezo-electric member 11i. It is (d) of drawing 10 about a charge. Although it is shorter than the time of a wave, fixed time amount maintenance is carried out, and it is piezo-electric member 11i. Fixed time amount maintenance is carried out in a predetermined displacement location. And it is piezo-electric member 11i after fixed time amount progress. A charge is discharged rapidly and it is piezo-electric member 11i. It returns to a steady state. In this way, piezo-electric member 11i The amount of ink which carries out the regurgitation from an ink room by supplying the short fixed voltage waveform which carries out time amount maintenance in a predetermined displacement location becomes whenever [middle]. That is, gradation concentration serves as printing which is whenever [middle].
[0044] Moreover, piezo-electric member 11i to drive Corresponding transistor 13i To the base, it is (g) of drawing 10 . It is reference voltage wave T1 so that it may be shown. The print pulse PP for choosing is supplied. thereby -- piezo-electric member 11i **** -- (h) of drawing 10 A supply voltage wave as shown will impress. This supply voltage wave is piezo-electric member 11i, if predetermined level is reached. It discharges immediately, without hardly holding a charge, and is piezo-electric member 11i. It returns to a steady state. In this way, piezo-electric member 11i The amount of ink which carries out the regurgitation from an ink room by discharging immediately, without holding a charge decreases. That is, it becomes low printing of gradation concentration. Thus, transistor 13i It is piezo-electric member 11i by the print pulse PP impressed to the base. By easy control of choosing the reference voltage wave to supply, the amount of ink which carries out the regurgitation from an ink room can be adjusted, and gradation printing can be performed.
[0045] (Gestalt of the 5th operation) The gestalt of this operation is what applied two or more ink rooms to the recording head of the share mode form which constituted the partition between that room from a piezo-electric member, and describes the gestalt of the operation corresponding to claims 1 and 2. As shown in drawing 14 , on the piezo-electric member 41 in which two or more concave slots were formed, and this piezo-electric member 41, the recording head of a share mode form is what the top plate 43 was made for another piezo-electric member 42 to rival cladding and on this, and formed two or more ink rooms 44 and 44 and --, and forms the electrode 45 by electroless nickel plating at the wall of each ink room 44. Said each piezo-electric members 41 and 42 are polarized in the direction which counters mutually in the direction of board thickness.
[0046] As the configuration of the drive circuit of the recording head of this share mode form is shown in drawing 11 Piezo-electric member 421 which constitutes the adjoining wall 422 Connected electrode 451 Bidirectional switch 461 It minds and is the criteria voltage waveform BV1. Supply line 471 It connects. Piezo-electric member 422 which constitutes the adjoining wall 423 Connected electrode 452 Bidirectional switch 462 It minds and is the criteria voltage waveform BV2. Supply line 472 It connects. Piezo-electric member 423 which constitutes the adjoining wall 424 Connected electrode 453 Bidirectional switch 463 It minds and is the criteria voltage waveform BV3. Supply line 473 It connects. Piezo-electric member 424 which constitutes the adjoining wall 425 Connected electrode 454 Bidirectional switch 464 It minds and is the criteria voltage waveform BV1. Supply line 471 It connects. Piezo-electric member 425 which constitutes the adjoining wall 426 Connected electrode 455 Bidirectional switch 465 It minds and is the criteria voltage waveform BV2. Supply line 472 It connects. Piezo-electric member 426 which constitutes the adjoining wall 427 Connected electrode 456 Bidirectional switch 466 It minds and is the criteria voltage waveform BV3. Supply line 473 It connects and has the composition --.

[0047] Although the method of 2 division drives or a trichotomy drive is taken since the recording head of a share mode form cannot drive an adjoining ink room to coincidence on the structure, the above-mentioned drive circuit performs a trichotomy drive. Said each bidirectional switch 461, 462, 463, 464, 465, 466, and -- carry out SUITCHIN control by two control signal A1H, A1L and B1H, B1L and C1H, C1L and A2H, A2L and B-2H, B-2L and C2H, C2L, and --, respectively. This control signal performs selection of an ink room, and control of ink discharge quantity. In addition, the inside A1 of drawing, B1 and C1, A2, B-2, C2, and -- show the ink room, respectively.
[0048] This drive circuit is each supply line 471, 472, and 473. They are each reference voltage wave BV1, BV2, and BV3. (a) of drawing 12 (b) (c) It supplies to the shown timing. Now and supply line 471 Reference voltage wave BV1 It is (d) of drawing 12 at the timing to supply. Control signal A1H are turned on so that it may be shown. (e) of drawing 12 Control signal A1L is turned off so that it may be shown, and it is (f) of drawing 12 . Control signal B1H are turned off so that it may be shown, and it is (g) of drawing 12 . If control signal B1L is turned on so that it may be shown The bidirectional switch 461 and 462 It minds and is the piezo-electric member 421 and 422. Reference voltage wave BV1 It impresses and is the piezo-electric member 421 and 422. Ink room A1 (a) of drawing 13 (b) of a steady state to drawing 13 It displaces in the direction gradually opened so that it may be shown.
[0049] And criteria voltage waveform BV1 When control signal A1H are turned off just before falling, it is the piezo-electric member 421 and 422. (c) of drawing 13 The displacement condition is held so that it may be shown. Then, it is [changing the timing which returns this control signal A1L to ON, although control signal A1L is returned to ON, and] the ink room A1. Electrode 451 The voltage waveform to supply is (j) of drawing 12 . It changes so that it may be shown. Namely, the piezo-electric member 421 and 422 The electrical-potential-difference holding time changes. and -- if the fixed holding time passes -- control signal A1L -- an ON state -- returning -- the piezo-electric member 421 and 422 a charge -- **** -- discharging -- this piezo-electric member 421 and 422 (d) of drawing 13 it is shown -- as -- a steady state -- returning -- ink room A1 from -- ink is made to breathe out through an ink delivery
[0050] in this way, the thing for which the timing which returns control signal A1L to ON is changed -- the piezo-electric member 421 and 422 the gestalt of the 1st operation mentioned above since the electrical-potential-difference holding time changed -- the same -- ink room A1 from -- the discharge quantity of ink can be changed and gradation printing is attained.
[0051] Next, supply line 472 Reference voltage wave BV2 It is (f) of drawing 12 at the timing to supply. Control signal B1H are turned on so that it may be shown. (g) of drawing 12 Control signal B1L is turned off so that it may be shown, and it is (d) of drawing 12 . Control signal A1H are turned off so that it may be shown. As shown in (e) of drawing 12 , control signal A1L is turned on, and it is (h) of drawing 12 . Control signal C1H are turned off so that it may be shown, and it is (i) of drawing 12 . If control signal C1L is turned on so that it may be shown The bidirectional switch 461, 462, and 463 It minds and is the piezo-electric member 422 and 423. Reference voltage wave BV2 impresses and it is the piezo-electric member 422 and 423. Ink room B1 (e) of drawing 13 (f) of a steady state to drawing 13 It displaces in the direction gradually opened so that it may be shown.
[0052] And criteria voltage waveform BV2 When control signal B1H are turned off just before falling, it is the piezo-electric member 422 and 423. The displacement condition is held. Then, it is [changing the timing which returns this control signal B1L to ON, although control signal B1L is returned to ON, and] the ink room B1. Electrode 452 The voltage waveform to supply is (k) of drawing 12 . It changes so that it may be shown. Namely, the piezo-electric member 422 and 423 The electrical-potential-difference holding time changes. and -- if the fixed holding time passes -- control signal B1L -- an ON state -- returning -- the piezo-electric member 422 and 423 a charge -- **** -- discharging -- this piezo-electric member 422 and 423 a steady state -- returning -- ink room B1 from -- ink is made to breathe out through an ink delivery
[0053] in this way, the thing for which the timing which returns control signal B1L to ON is changed -- the piezo-electric member 422 and 423 the gestalt of the 1st operation mentioned above since the electrical-potential-difference holding time changed -- the same -- ink room B1 from -- the discharge quantity of ink can be changed and gradation printing is attained.
[0054] Similarly, it is a supply line 473. Reference voltage wave BV3 It is (h) of drawing 12 at the timing to supply. Control signal C1H are turned on so that it may be shown. (i) of drawing 12 Control signal C1L is turned off so that it may be shown, and it is (d) of drawing 12 . Control signal A1H are turned off so that it may be shown. (e) of drawing 12 Control signal A1L is turned on so that it may be shown, and it is (f) of drawing 12 . Control signal B1H are turned off so that it may be shown, and it is (g) of drawing 12 . If control signal B1L is turned on so that it may be shown The bidirectional switch 462, 463, and 464 It minds and is the piezo-electric member 423 and 424. Reference voltage wave BV3 It impresses and is the piezo-electric member 423 and 424. Ink room C1 It displaces in the direction gradually opened from a steady state.
[0055] And criteria voltage waveform BV3 When control signal C1H are turned off just before falling, it is the piezo-electric member 423 and 424. The displacement condition is held. Then, it is [changing the timing which returns this

control signal C1L to ON, although control signal C1L is returned to ON, and] the ink room C1. Electrode 453 The voltage waveform to supply is (I) of drawing 12 . It changes so that it may be shown. Namely, the piezo-electric member 423 and 424 The electrical-potential-difference holding time changes. and -- if the fixed holding time passes -- control signal C1L -- an ON state -- returning -- the piezo-electric member 423 and 424 a charge -- **** -- discharging -- this piezo-electric member 423 and 424 a steady state -- returning -- ink room C1 from -- ink is made to breathe out through an ink delivery

[0056] in this way, the thing for which the timing which returns control signal C1L to ON is changed -- the piezo-electric member 423 and 424 the gestalt of the 1st operation mentioned above since the electrical-potential-difference holding time changed -- the same -- ink room C1 from -- the discharge quantity of ink can be changed and gradation printing is attained.

[0057] Thus, when carrying out a trichotomy drive in the recording head of a share mode form, actuation of the ink room in every two is attained at coincidence, therefore, which ink room is operated decides on ON of control signals AiH, BiH, and CiH off [control signals AiL BiL, and CiL], and it becomes possible because gradation control changes the ON return timing of control signals AiL, BiL, and CiL. In addition, control signals AiH, BiH, CiH, AiL, BiL, and CiL i shows 1, 2, 3, and --.

[0058] (Gestalt of the 6th operation) The gestalt of this operation describes the case where an ink room is alternately used in the recording head of a share mode form. This drive circuit is the piezo-electric member 511 which constitutes the adjoining wall as shown in drawing 15 . 522 Connected electrode 521 It connects with the supply line 54 of a reference voltage wave. Piezo-electric member 512 which constitutes the adjoining wall 513 Connected electrode 522 NPN transistor 531 It minds and grounds. Piezo-electric member 513 which constitutes the adjoining wall 514 Connected electrode 523 It connects with said supply line 54. Piezo-electric member 514 which constitutes the adjoining wall 515 Connected electrode 524 NPN transistor 532 It minds and grounds. Piezo-electric member 515 which constitutes the adjoining wall 516 Piezo-electric member 516 which connects the connected electrode 525 to said supply line 54, and constitutes the adjoining wall Electrode 526 linked to 517 NPN transistor 533 It minds, and it grounds and has the composition --. And said piezo-electric member 512 513 The ink room A1 is formed in between, and it is said piezo-electric member 514. 515 It is the ink room A2 in between. It forms and is said piezo-electric member 516. 517 It is ink room A3 in between. It forms, an ink room is alternately formed like --, and others have become the mere space section which is not filled up with ink. In the case of this recording head, since the ink room is formed alternately, it is possible to operate all ink rooms to coincidence. Moreover, each piezo-electric member 511-517 The reference voltage wave and each transistor 531 which are supplied to the supply line 54 for driving --, 532, and 533 And the timing of the print pulse PP which carries out OFF actuation is the same as that of the case of drawing 2 in the gestalt of the 1st operation mentioned above.

[0059] That is, the reference voltage wave of a triangular wave is supplied to a supply line 54, and it is each transistor 531, 532, and 533 to coincidence. If the print pulse PP is supplied and ON actuation is carried out Each piezo-electric member 512, 513, 514, 515, 516, and 517 A reference voltage wave impresses, respectively. Piezo-electric member 512 513 Ink room A1 It displaces so that it may open gradually, and it is the piezo-electric member 514. 515 Ink room A2 It displaces so that it may open gradually, and it is the piezo-electric member 516. 517 Ink room A3 It displaces so that it may open gradually. Namely, the ink room A1, A2, and A3 (a) of drawing 16 (b) of a steady state to drawing 16 It changes so that it may be shown.

[0060] just before [then,] a reference voltage wave falls -- each transistor 531, 532, and 533 it once turns off -- making -- each piezo-electric member 512, 513, 514, 515, 516, and 517 a variation rate -- a condition -- (c) of drawing 16 It is made to hold so that it may be shown. and this holding time -- suitable -- controlling -- each transistor 531, 532, and 533 if ON actuation is carried out again -- each piezo-electric member 512, 513, 514, 515, 516, and 517 It returns to a steady state rapidly. namely, the ink room A1, A2, and A3 (c) of drawing 16 (d) of a condition to drawing 16 a condition -- changing -- each ink room A1, A2, and A3 from -- ink carries out the regurgitation. each ink room A1 at this time, A2, and A3 from -- the discharge quantity of ink -- each piezo-electric member 512, 513, 514, 515, 516, and 517 a variation rate -- it can control by adjusting the die length of the time amount holding a condition, and, thereby, gradation printing is attained. Then, each ink room A1, A2, and A3 (e) of drawing 16 It stands by by the shown steady state, and comes to prepare for the following printing timing.

[0061] Thus, when printing 300dpi by this recording head, as a recording head, the thing of 600dpi is needed, since the ****** space section does not use it with an ink room when using an ink room alternately in the recording head of a share mode form, for example.

[0062] In addition, although the gestalt of the 5th and the 6th operation mentioned above described the case where gradation control was carried out by carrying out adjustable [of the holding time in the condition that the piezo-electric member displaced] By carrying out adjustable [of the maintenance voltage level in the condition that the piezo-electric member displaced] like the recording head of the KAISA method mentioned above also in the recording head of such a

share mode form, carrying out gradation control can also carry out adjustable [of both maintenance voltage levels] to the holding time, and it can also carry out gradation control.

[0063]

[Effect of the Invention] As mentioned above, according to invention according to claim 1 to 6, in the recording head which impresses an electrical potential difference to a piezo-electric member, is made to carry out the variation rate of this piezo-electric member, is made to transform an ink room with the variation rate of this piezo-electric member, and performs discharge printing for the ink of this ink interior of a room, the adjustable control of the discharge quantity of the ink from an ink room can be carried out in easy control, and gradation printing can be performed.

[Translation done.]

CLAIMS

[Claim(s)]
[Claim 1] In the recording head which impresses an electrical potential difference to a piezo-electric member, is made to carry out the variation rate of this piezo-electric member, is made to transform an ink room with the variation rate of this piezo-electric member, and performs discharge printing for the ink of this ink interior of a room Impress a reference voltage wave for every printing timing to said piezo-electric member, hold the impression condition of an electrical potential difference over said piezo-electric member in the impression period of this reference voltage wave, and the displacement condition of this piezo-electric member is held. The drive approach of the recording head characterized by carrying out adjustable [of the discharge quantity of ink] by changing the holding time at this time, and performing gradation printing.
[Claim 2] In the recording head which impresses an electrical potential difference to a piezo-electric member, is made to carry out the variation rate of this piezo-electric member, is made to transform an ink room with the variation rate of this piezo-electric member, and performs discharge printing for the ink of this ink interior of a room Carry out ON actuation of the switching element, and the electrode of another side connected to said piezo-electric member while while connecting with said piezo-electric member impresses a reference voltage wave for every printing timing to an electrode is grounded. In the impression period of a reference voltage wave over said piezo-electric member, carry out off actuation of said switching element, hold the impression condition of an electrical potential difference over said piezo-electric member, and the displacement condition of this piezo-electric member is held. The drive approach of the recording head characterized by changing the holding time by changing the ON actuation timing of said subsequent switching element, carrying out adjustable [of the discharge quantity of ink], and performing gradation printing.
[Claim 3] In the recording head which impresses an electrical potential difference to a piezo-electric member, is made to carry out the variation rate of this piezo-electric member, is made to transform an ink room with the variation rate of this piezo-electric member, and performs discharge printing for the ink of this ink interior of a room The reference voltage wave from which a voltage level changes to said piezo-electric member is impressed for every printing timing. The drive approach of the recording head characterized by holding the impression condition of an electrical potential difference over said piezo-electric member in the impression period of this reference voltage wave, holding the displacement condition of this piezo-electric member, carrying out adjustable [of the discharge quantity of ink] by changing the maintenance electrical potential difference at this time, and performing gradation printing.
[Claim 4]

DESCRIPTION OF DRAWINGS

[Brief Description of the Drawings]
[Drawing 1] The circuitry Fig. of a recording head drive circuit showing the gestalt of operation of the 1st of this invention.
[Drawing 2] The pulse shape and the electrical-potential-difference wave form chart showing the timing of operation in the gestalt of this operation.
[Drawing 3] The mimetic diagram for explaining the printing principle in the gestalt of this operation.
[Drawing 4] The sectional view showing an example of the recording head used with the gestalt of this operation.
[Drawing 5] The pulse shape and the electrical-potential-difference wave form chart showing the timing of operation in the gestalt of operation of the 2nd of this invention.
[Drawing 6] The mimetic diagram for explaining the printing principle in the gestalt of this operation.
[Drawing 7] The pulse shape and the electrical-potential-difference wave form chart showing the timing of operation in the gestalt of operation of the 3rd of this invention.
[Drawing 8] The mimetic diagram for explaining the printing principle in the gestalt of this operation.
[Drawing 9] The circuitry Fig. of a recording head drive circuit showing the gestalt of operation of the 4th of this invention.
[Drawing 10] The pulse shape and the electrical-potential-difference wave form chart showing the timing of operation in the gestalt of this operation.
[Drawing 11] The circuitry Fig. of a recording head drive circuit showing the gestalt of operation of the 5th of this invention.
[Drawing 12] The control signal wave and electrical-potential-difference wave form chart showing the timing of operation in the gestalt of this operation.
[Drawing 13] The mimetic diagram for explaining the printing principle in the gestalt of this operation.
[Drawing 14] The fragmentary sectional view showing the configuration of the recording head in the gestalt of this operation.
[Drawing 15] The circuitry Fig. of a recording head drive circuit showing the gestalt of operation of the 6th of this invention.
[Drawing 16] The mimetic diagram for explaining the printing principle in the gestalt of this operation.
[Drawing 17] The circuitry Fig. of a recording head drive circuit showing the conventional example.
[Description of Notations]
111 - 116, 11I, and 23 -- Piezo-electricity Member
12 -- Current supply circuit
131 - 136 and 13I -- NPN Transistor
14 -- Printing data-conversion circuit
17 21 -- Ink room

[Translation done.]

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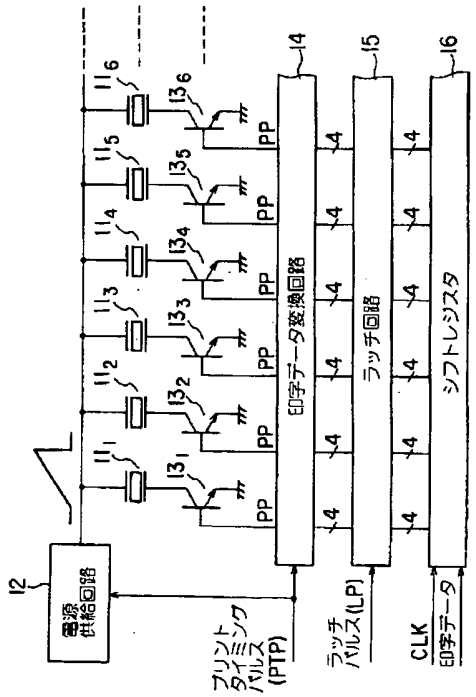
最終頁に続く

(54)【発明の名称】　記録ヘッドの駆動方法

(57)【要約】

【課題】簡単な制御でインク室からのインク吐出量を可変し階調印刷を行う。

【解決手段】電源供給回路１２から三角波の基準電圧波形を出力し、圧電部材１１ｉに印加する。また、駆動したい圧電部材に対応したトランジスタ１３ｉを圧電部材への基準電圧波形の印加と同時にオン動作する。これによりインク室は開く。その後、基準電圧波形が接地電位に急俊に立ち下がる直前でトランジスタを一旦オフ動作する。これにより圧電部材は電荷を保持しその変位位置を保持する。このときインク室へのインクの補充を行う。そして適当な保持時間経過後、トランジスタを再びオン動作して圧電部材を定常状態に戻す。これによりインク室は急激に元の状態に戻り、これによりインク室からインクが吐出する。このときのインク吐出量は保持時間を可変することで可変でき、階調印刷ができる。



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【特許請求の範囲】

【請求項１】　圧電部材に電圧を印加してこの圧電部材を変位させ、この圧電部材の変位によりインク室を変形させてこのインク室内のインクを吐出し印刷を行う記録ヘッドにおいて、

前記圧電部材に対して基準電圧波形を印刷タイミング毎に印加し、この基準電圧波形の印加期間において前記圧電部材に対する電圧の印加状態を保持してこの圧電部材の変位状態を保持し、このときの保持時間を変化させることでインクの吐出量を可変して階調印刷を行うことを特徴とする記録ヘッドの駆動方法。

【請求項２】　圧電部材に電圧を印加してこの圧電部材を変位させ、この圧電部材の変位によりインク室を変形させてこのインク室内のインクを吐出し印刷を行う記録ヘッドにおいて、

前記圧電部材に接続する一方の電極に対して基準電圧波形を印刷タイミング毎に印加するとともに前記圧電部材に接続する他方の電極をスイッチング素子をオン動作して接地し、前記圧電部材に対する基準電圧波形の印加期間において前記スイッチング素子をオフ動作して前記圧電部材に対する電圧の印加状態を保持してこの圧電部材の変位状態を保持し、その後の前記スイッチング素子のオン動作タイミングを変化させることで保持時間を変化させ、インクの吐出量を可変して階調印刷を行うことを特徴とする記録ヘッドの駆動方法。

【請求項３】　圧電部材に電圧を印加してこの圧電部材を変位させ、この圧電部材の変位によりインク室を変形させてこのインク室内のインクを吐出し印刷を行う記録ヘッドにおいて、

前記圧電部材に対して電圧レベルが変化する基準電圧波形を印刷タイミング毎に印加し、この基準電圧波形の印加期間において前記圧電部材に対する電圧の印加状態を保持してこの圧電部材の変位状態を保持し、このときの保持電圧を変化させることでインクの吐出量を可変して階調印刷を行うことを特徴とする記録ヘッドの駆動方法。

【請求項４】　圧電部材に電圧を印加してこの圧電部材を変位させ、この圧電部材の変位によりインク室を変形させてこのインク室内のインクを吐出し印刷を行う記録ヘッドにおいて、

前記圧電部材に接続する一方の電極に対して電圧レベルが変化する基準電圧波形を印刷タイミング毎に印加するとともに前記圧電部材に接続する他方の電極をスイッチング素子をオン動作して接地し、前記圧電部材に対する基準電圧波形の印加期間において前記スイッチング素子をオフ動作して前記圧電部材に対する電圧の印加状態を保持してこの圧電部材の変位状態を保持し、このときの前記スイッチング素子のオフ動作タイミングを変化させることで前記圧電部材に対する保持電圧を変化させインクの吐出量を可変して階調印刷を行うことを特徴とする記録ヘッドの駆動方法。

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【請求項５】　圧電部材に電圧を印加してこの圧電部材を変位させ、この圧電部材の変位によりインク室を変形させてこのインク室内のインクを吐出し印刷を行う記録ヘッドにおいて、

前記圧電部材に接続する一方の電極に対して電圧レベルが変化する基準電圧波形を印刷タイミング毎に印加するとともに前記圧電部材に接続する他方の電極をスイッチング素子をオン動作して接地し、前記圧電部材に対する基準電圧波形の印加期間において前記スイッチング素子をオフ動作して前記圧電部材に対する電圧の印加状態を保持してこの圧電部材の変位状態を保持し、このときの前記スイッチング素子のオフ動作タイミングを変化させることで前記圧電部材に対する保持電圧を変化させ、かつその後の前記スイッチング素子のオン動作タイミングを変化させることで保持時間を変化させ、これにより、インクの吐出量を可変して階調印刷を行うことを特徴とする記録ヘッドの駆動方法。

【請求項６】　圧電部材に電圧を印加してこの圧電部材を変位させ、この圧電部材の変位によりインク室を変形させてこのインク室内のインクを吐出し印刷を行う記録ヘッドにおいて、

前記圧電部材に接続する一方の電極に対して各階調印刷に対応した複数種の基準電圧波形を印刷タイミング毎に連続して印加し、前記圧電部材に接続する他方の電極をスイッチング素子をオン動作して接地するときのタイミングを制御して前記圧電部材の各電極間に印加する基準電圧波形を選択することでインクの吐出量を可変して階調印刷を行うことを特徴とする記録ヘッドの駆動方法。

【発明の詳細な説明】

【０００１】

【発明の属する技術分野】本発明は、圧電部材の変形によりインク室からインクを吐出する記録ヘッドの駆動方法に関する。

【０００２】

【従来の技術】この種の記録ヘッドの駆動方法としては、例えば、特開平２－１６４５４４号公報のものが知られている。これは、図１７に示すように、圧電部材１１，１２，１３，１４，１５，１６，…に接続した一方の電極を共通電極として電源供給回路２の出力端子に接続し、他方の電極をそれぞれＮＰＮ形トランジスタ３１，３２，３３，３４，３５，３６，…を介して接地している。そして、圧電部材１１，１２，１３，１４，１５，１６，…を駆動する場合は、トランジスタ３１，３２，３３，３４，３５，３６，…をオン状態にして電源供給回路２の出力端子から各圧電部材に定電流入力を行うようになっている。すなわち、電源供給回路２の出力端子から各圧電部材の共通電極に駆動電圧波形を印加しトランジスタ３１，３２，３３，３４，３５，３６，…を選択的にオン動作することで駆動する圧電部材を選択

して該当するインク室のインク吐出口からインクを吐出させるようにしている。

【０００３】

【発明が解決しようとする課題】この従来の駆動方法は、トランジスタ３１，３２，３３，３４，３５，３６，…によって駆動する圧電部材を選択する制御のみを行うものであるので、インクの吐出量を可変して階調印刷を行うことはできなかった。

【０００４】そこで、請求項１乃至６記載の発明は、簡単な制御でインク室からのインクの吐出量を可変制御でき、階調印刷ができる記録ヘッドの駆動方法を提供する。

【０００５】

【課題を解決するための手段】請求項１記載の発明は、圧電部材に電圧を印加してこの圧電部材を変位させ、この圧電部材の変位によりインク室を変形させてこのインク室内のインクを吐出し印刷を行う記録ヘッドにおいて、圧電部材に対して基準電圧波形を印刷タイミング毎に印加し、この基準電圧波形の印加期間において圧電部材に対する電圧の印加状態を保持してこの圧電部材の変位状態を保持し、このときの保持時間を変化させることでインクの吐出量を可変して階調印刷を行うことにある。

【０００６】請求項２記載の発明は、圧電部材に電圧を印加してこの圧電部材を変位させ、この圧電部材の変位によりインク室を変形させてこのインク室内のインクを吐出し印刷を行う記録ヘッドにおいて、圧電部材に接続する一方の電極に対して基準電圧波形を印刷タイミング毎に印加するとともに圧電部材に接続する他方の電極をスイッチング素子をオン動作して接地し、圧電部材に対する基準電圧波形の印加期間においてスイッチング素子をオフ動作して圧電部材に対する電圧の印加状態を保持してこの圧電部材の変位状態を保持し、その後のスイッチング素子のオン動作タイミングを変化させることで保持時間を変化させ、インクの吐出量を可変して階調印刷を行うことにある。

【０００７】請求項３記載の発明は、圧電部材に電圧を印加してこの圧電部材を変位させ、この圧電部材の変位によりインク室を変形させてこのインク室内のインクを吐出し印刷を行う記録ヘッドにおいて、圧電部材に対して電圧レベルが変化する基準電圧波形を印刷タイミング毎に印加し、この基準電圧波形の印加期間において圧電部材に対する電圧の印加状態を保持してこの圧電部材の変位状態を保持し、このときの保持電圧を変化させることでインクの吐出量を可変して階調印刷を行うことにある。

【０００８】請求項４記載の発明は、圧電部材に電圧を印加してこの圧電部材を変位させ、この圧電部材の変位によりインク室を変形させてこのインク室内のインクを吐出し印刷を行う記録ヘッドにおいて、圧電部材に接続する一方の電極に対して電圧レベルが変化する基準電圧波形を印刷タイミング毎に印加するとともに圧電部材に接続する他方の電極をスイッチング素子をオン動作して接地し、圧電部材に対する基準電圧波形の印加期間においてスイッチング素子をオフ動作して圧電部材に対する電圧の印加状態を保持してこの圧電部材の変位状態を保持し、このときのスイッチング素子のオフ動作タイミングを変化させることで圧電部材に対する保持電圧を変化させインクの吐出量を可変して階調印刷を行うことにある。

【０００９】請求項５記載の発明は、圧電部材に電圧を印加してこの圧電部材を変位させ、この圧電部材の変位によりインク室を変形させてこのインク室内のインクを吐出し印刷を行う記録ヘッドにおいて、圧電部材に接続する一方の電極に対して電圧レベルが変化する基準電圧波形を印刷タイミング毎に印加するとともに圧電部材に接続する他方の電極をスイッチング素子をオン動作して接地し、圧電部材に対する基準電圧波形の印加期間においてスイッチング素子をオフ動作して圧電部材に対する電圧の印加状態を保持してこの圧電部材の変位状態を保持し、このときのスイッチング素子のオフ動作タイミングを変化させることで圧電部材に対する保持電圧を変化させ、かつその後のスイッチング素子のオン動作タイミングを変化させることで保持時間を変化させ、これにより、インクの吐出量を可変して階調印刷を行うことにある。

【００１０】請求項６記載の発明は、圧電部材に電圧を印加してこの圧電部材を変位させ、この圧電部材の変位によりインク室を変形させてこのインク室内のインクを吐出し印刷を行う記録ヘッドにおいて、圧電部材に接続する一方の電極に対して各階調印刷に対応した複数種の基準電圧波形を印刷タイミング毎に連続して印加し、圧電部材に接続する他方の電極をスイッチング素子をオン動作して接地するときのタイミングを制御して圧電部材の各電極間に印加する基準電圧波形を選択することでインクの吐出量を可変して階調印刷を行うことにある。

【００１１】

【発明の実施の形態】以下、本発明の実施の形態を図面を参照して説明する。

（第１の実施の形態）この実施の形態は請求項１及び２に対応した実施の形態について述べる。図１に示すように、複数の圧電部材１１１，１１２，１１３，１１４，１１５，１１６，…を設け、この各圧電部材１１１～１１６，…に接続した一方の電極を共通電極として電源供給回路１２の出力端子に接続している。前記各圧電部材１１１～１１６，…に接続した他方の電極をＮＰＮ形トランジスタ１３１，１３２，１３３，１３４，１３５，１３６，…をそれぞれ介して接地している。

【００１２】前記各トランジスタ１３１～１３６，…のベースを印字データ変換回路１４に接続し、このベース

に対して印字データ変換回路１４からプリントパルス信号ＰＰを印加するようになっている。前記印字データ変換回路１４はラッチ回路１５に接続し、前記ラッチ回路１５はシフトレジスタ１６に接続している。

【００１３】この駆動回路は、１６階調（４ビット）の印字データをクロックＣＬＫに同期して前記シフトレジスタ１６に順次シフトして格納し、各圧電部材１１１～１１６，…に対応した印字データを前記シフトレジスタ１６に格納すると、ラッチパルスＬＰの入力によって前記ラッチ回路１５にラッチし、前記印字データ変換回路１４に入力する。前記印字データ変換回路１４は入力した印字データを前記各トランジスタ１３1～１３６，…をオン、オフ動作するためのプリントパルスＰＰに変換する。前記電源供給回路１２は、各圧電部材１１１～１１６，…の共通電極に滑らかな立上がりと急俊な立下がりをもつ三角波の基準電圧波形を印刷タイミング毎に印加するようになっている。

【００１４】ここで、図３に示す模式図を使用して印刷原理について述べる。先ず、定常状態では図３の(d) に示すように圧電部材１１ｉ（ｉ=1,2,3,…）は変位せずインク室１７にインクは充満している。この状態でトランジスタ１３ｉ（ｉ=1,2,3,…）をオンにして電源供給回路１２から圧電部材１１ｉに基準電圧波形を印加すると、先ず滑らかな立上がりにより圧電部材１１ｉはインク室１７を開くように変位する。このときインクのインク吐出面、すなわち、メニスカス１８は図３の(a) に示すようにインク室１７側に後退する。

【００１５】この状態で直ぐに圧電部材１１ｉに印加する基準電圧波形を急俊に接地電位に立下げると、圧電部材１１ｉは図３の(d) に示す定常状態に復帰するが、このときにはインク室１７へのインクの補充がほとんど行われないので、インク室１７からのインクの吐出量は少ない。すなわち、階調濃度の低い印刷となる。

【００１６】また、図３の(a) に示すようにメニスカス１８がインク室１７側に後退した状態で暫く保持すると、インク室１７へのインクの補充が行われ、メニスカス１８は図３の(b) に示すようにインク吐出面に戻るようになる。従って、この状態で圧電部材１１ｉに印加する基準電圧波形を急俊に接地電位に立下げると、圧電部材１１ｉは図３の(d) に示す定常状態に復帰するが、このときにはインク室１７へのインクの補充がある程度行われているので、インク室１７からのインクの吐出量は若干多くなる。すなわち、階調濃度が中程度の印刷となる。

【００１７】また、図３の(a) に示すようにメニスカス１８がインク室１７側に後退した状態で長く保持すると、インク室１７へのインクの補充が充分に行われ、メニスカス１８は図３の(c) に示すようにインク吐出面まで完全に戻るようになる。従って、この状態で圧電部材１１ｉに印加する基準電圧波形を急俊に接地電位に立下げると、圧電部材１１ｉは図３の(d) に示す定常状態に復帰するが、このときにはインク室１７へのインクの補充が充分に行われているので、インク室１７からのインクの吐出量は多くなる。すなわち、階調濃度の高い印刷となる。こうして後退したメニスカスの復帰位置によりインク吐出タイミングを決めることでインクの吐出量を調整でき、階調印刷が可能になる。

【００１８】そこで、図１の駆動回路では、印刷タイミングになると、図２の(a) に示すように、プリントタイミングパルスＰＴＰを電源供給回路１２及び印字データ変換回路１４に供給し、電源供給回路１２から図２の(b) に示すような基準電圧波形を出力する。また、駆動したい圧電部材１１ｉに対応したトランジスタ１３ｉのベースに、例えば、図２の(c) に示すようなプリントパルスＰＰを供給する。すなわち、圧電部材１１ｉへの基準電圧波形の印加と同時にトランジスタ１３ｉをオン動作し、基準電圧波形が接地電位に急俊に立ち下がる直前でトランジスタ１３ｉを一旦オフ動作する。圧電部材１１ｉは容量負荷なのでトランジスタ１３ｉがオフしても電荷を保持することなり、その変位位置を保持することになる。

【００１９】その後、この状態を比較的長い時間保持してからトランジスタ１３ｉを再びオン動作することで圧電部材１１ｉの電荷は急激に放電し圧電部材１１ｉは定常状態に戻る。こうして、圧電部材１１ｉに供給される電圧波形は図２の(d) に示すようになり、この電圧波形が立ち下がるタイミングでインク室から吐出するインク量は多くなる。すなわち、階調濃度の高い印刷となる。

【００２０】また、トランジスタ１３ｉのベースに印加するプリントパルスＰＰを、図２の(e) に示すように変化させると、圧電部材１１ｉが電荷を保持する期間は若干短くなり、このときには圧電部材１１ｉに供給される電圧波形は図２の(f) に示すようになり、この電圧波形が立ち下がるタイミングでインク室から吐出するインク量は若干少なくなる。すなわち、階調濃度が中程度の印刷となる。

【００２１】また、トランジスタ１３ｉのベースに印加するプリントパルスＰＰを、図２の(g) に示すように変化させると、圧電部材１１ｉが電荷を保持する期間はさらに短くなり、このときには圧電部材１１ｉに供給される電圧波形は図２の(h) に示すようになり、この電圧波形が立ち下がるタイミングでインク室から吐出するインク量は少なくなる。すなわち、階調濃度の低い印刷となる。

【００２２】このように、トランジスタ１３ｉのベースに印加するプリントパルスＰＰを変化して圧電部材１１ｉが電荷を保持する期間を可変する簡単な制御により、インク室から吐出するインク量を調整することができ、階調印刷ができる。

【００２３】このような制御に使用する記録ヘッドとし

ては、例えば，図４に示すカイザー方式の記録ヘッドがある。この記録ヘッドは、インク室２１の上面を弾性板２２で構成し、この弾性板２２の上に圧電部材２３を両側に電極２４，２５を設けて固定している。そして、インク吐出口２６の反対側にインク供給口２７を設け、インク室内へのインクの補充を行うようになっている。

【００２４】この記録ヘッドは、図４の(a) に示す定常状態において、圧電部材２３に三角波の電圧波形を印加すると、電圧の滑らかな立上がりにおいて圧電横効果により圧電部材２３は面方向に収縮し、弾性板２２との応力の釣合いにより曲げモーメントが発生し、弾性板２２は図４の(b) に示すようにインク室２１の容積を拡大する方向に変形する。そして、圧電部材２３を変位した状態で一定時間保持した後に印加電圧を急俊に立下げると、圧電部材２３は図４の(c) に示すように定常状態に復帰し、これによりインク室２１の容積が元に戻りインク吐出口２６からインクが吐出する。

【００２５】（第２の実施の形態）この実施の形態は請求項１及び２に対応した実施の形態について述べる。この実施の形態の駆動回路の構成は基本的には第１の実施の形態と同様である。異なる点は、電源供給回路１２から各圧電部材１１１～１１６，…の一方の電極に印加する基準電圧波形を変えた点である。

【００２６】すなわち、図５に動作タイミングを示し、図６に印刷原理を模式的に示すように、この実施の形態においては、図５の(a) に示すプリントタイミングパルスＰＴＰにより電源供給回路１２から各圧電部材１１１～１１６，…の一方の電極に印加する基準電圧波形が出力する。この基準電圧波形は、図５の(b) に示すように負の電位に急俊に立ち下がり、一定時間後に急俊に立ち上がる矩形波になっている。

【００２７】このような基準電圧波形を印加することで、図５の(c) に示すブリンタパルスＰＰがトランジスタ１３ｉに印加すると、圧電部材１１ｉは図６の(d) に示す定常状態からインク室１７内のインクを押出す方向に変位する。そして、基準電圧波形が立ち上がる直前においてトランジスタ１３ｉがオフ動作して圧電部材１１ｉの変位状態を保持する。この保持状態を比較的長く継続した後にトランジスタ１３ｉが再度オン動作して圧電部材１１ｉを定常状態に復帰させる。この制御により、圧電部材１１ｉへの供給電圧波形は図５の(d) に示すようになり、インク室１７内のインクは比較的長く圧電部材１１ｉの変位により押出されるので、このときには図６の(c) に示すようにインクの吐出量は多くなる。

【００２８】また、図５の(e) に示すブリンタパルスＰＰがトランジスタ１３ｉに印加すると、圧電部材１１ｉは図６の(d) に示す定常状態からインク室１７内のインクを押出す方向に変位する。そして、基準電圧波形が立ち上がる直前においてトランジスタ１３ｉがオフ動作して圧電部材１１ｉの変位状態を保持するが、今度は保持状態が余り長く継続しないうちにトランジスタ１３ｉが再度オン動作して圧電部材１１ｉを定常状態に復帰させる。この制御により、圧電部材１１ｉへの供給電圧波形は図５の(f) に示すようになり、インク室１７内のインクが圧電部材１１ｉの変位により押出される期間が若干短くなる。従って、このときには図６の(b) に示すようにインクの吐出量は中程度になる。

【００２９】また、図５の(g) に示すブリンタパルスＰＰがトランジスタ１３ｉに印加すると、圧電部材１１ｉは図６の(d) に示す定常状態からインク室１７内のインクを押出す方向に変位する。そして、基準電圧波形が立ち上がる直前においてトランジスタ１３ｉがオフ動作して圧電部材１１ｉの変位状態を保持するが、今度は保持状態がほとんど継続しないうちにトランジスタ１３ｉが再度オン動作して圧電部材１１ｉを定常状態に復帰させる。この制御により、圧電部材１１ｉへの供給電圧波形は図５の(h) に示すようになり、インク室１７内のインクが圧電部材１１ｉの変位により押出される期間がさらに短くなる。従って、このときには図６の(a) に示すようにインクの吐出量は少なくなる。

【００３０】このように、圧電部材１１ｉをインク室１７内のインクを押出す方向に変位させる場合であっても、圧電部材１１ｉが電荷を保持して変位状態を保持する期間を可変する簡単な制御により、インク室から吐出するインク量を調整することができ、階調印刷ができる。

【００３１】（第３の実施の形態）この実施の形態は請求項３及び４に対応した実施の形態について述べる。この実施の形態の駆動回路の構成は基本的には第１の実施の形態と同様である。異なる点は、印字データ変換回路１４から各トランジスタ１３１～１３６，…のベースに印加するブリントパルスＰＰを変えた点である。

【００３２】すなわち、図７に動作タイミングを示し、図８に印刷原理を模式的に示すように、この実施の形態においては、図７の(a) に示すブリントタイミングパルスＰＴＰの供給タイミングで電源供給回路１２から図７の(b) に示すような三角波の基準電圧波形を出力する。また、駆動したい圧電部材１１ｉに対応したトランジスタ１３ｉのベースに、例えば、図７の(c) に示すようなブリントパルスＰＰを供給する。すなわち、圧電部材１１ｉへの基準電圧波形の印加と同時にトランジスタ１３ｉをオン動作し、基準電圧波形が接地電位に急俊に立ち下がる直前でトランジスタ１３ｉを一旦オフ動作する。これにより、圧電部材１１ｉは電圧Ｖ1を印加した状態で電荷を保持する。すなわち、圧電部材１１ｉは図８の(d) に示す定常状態から図８の(a) に示すように大きく変位した状態で保持する。

【００３３】その後、この状態を一定時間保持してからトランジスタ１３ｉを再びオン動作することで圧電部材１１ｉの電荷は急激に放電し圧電部材１１ｉは図８の

(d) に示す定常状態に戻る。すなわち、圧電部材１１ｉに供給される電圧波形は図７の(d) に示すようになる。このように圧電部材１１ｉを比較的高い電圧Ｖ1 を印加した状態で保持させることで圧電部材１１ｉが定常状態に復帰するときの変位量を大きくし、これにより、インク室から吐出するインク量が多くなる。すなわち、階調濃度の高い印刷となる。

【００３４】また、駆動したい圧電部材１１ｉに対応したトランジスタ１３ｉのベースに、例えば、図７の(e) に示すようなプリントパルスＰＰを供給する。すなわち、圧電部材１１ｉへの基準電圧波形の印加と同時にトランジスタ１３ｉをオン動作し、基準電圧波形が滑らかに立ち上がっている後半でトランジスタ１３ｉを一旦オフ動作する。これにより、圧電部材１１ｉは電圧Ｖ2（＜Ｖ1）を印加した状態で電荷を保持する。すなわち、圧電部材１１ｉは図８の(d) に示す定常状態から図８の(b) に示すように中程度に変位した状態で保持する。

【００３５】その後、この状態を一定時間保持してからトランジスタ１３ｉを再びオン動作することで圧電部材１１ｉの電荷は急激には放電し圧電部材１１ｉは図８の(d)に示す定常状態に戻る。すなわち、圧電部材１１ｉに供給される電圧波形は図７の(f) に示すようになる。このように圧電部材１１ｉを中程度の電圧Ｖ2 を印加した状態で保持させることで圧電部材１１ｉが定常状態に復帰するときの変位量を中程度にし、これにより、インク室から吐出するインク量を中程度に制御する。すなわち、階調濃度が中程度の印刷となる。

【００３６】また、駆動したい圧電部材１１ｉに対応したトランジスタ１３ｉのベースに、例えば、図７の(g) に示すようなプリントパルスＰＰを供給する。すなわち、圧電部材１１ｉへの基準電圧波形の印加と同時にトランジスタ１３ｉをオン動作し、基準電圧波形が滑らかに立ち上がっている前半でトランジスタ１３ｉを一旦オフ動作する。これにより、圧電部材１１ｉは電圧Ｖ3（＜Ｖ2）を印加した状態で電荷を保持する。すなわち、圧電部材１１ｉは図８の(d) に示す定常状態から図８の(c) に示すようにそれほど変位していない状態で保持する。

【００３７】その後、この状態を一定時間保持してからトランジスタ１３ｉを再びオン動作することで圧電部材１１ｉの電荷は急激には放電し圧電部材１１ｉは図８の(d)に示す定常状態に戻る。すなわち、圧電部材１１ｉに供給される電圧波形は図７の(h) に示すようになる。このように圧電部材１１ｉを比較的低い電圧Ｖ3 を印加した状態で保持させることで圧電部材１１ｉが定常状態に復帰するときの変位量を小さくし、これにより、インク室から吐出するインク量を少なくする。すなわち、階調濃度の低い印刷となる。このように圧電部材１１ｉが電荷を保持するときの電圧レベルを可変する簡単な制御により、インク室から吐出するインク量を調整することができ、階調印刷ができる。

【００３８】なお、この実施の形態では、圧電部材１１ｉが電荷を保持するときの電圧レベルを可変してインク量を調整するようにしたが、これにさらに圧電部材１１ｉが電荷を保持するときの保持時間を加味して電圧と保持時間の両方でインク量を調整すればより細かい階調制御が可能になる。これを実現するには、図７の(c) 、(e) 、(g) においてトランジスタ１３ｉを再度オン動作するプリントパルスＰＰのパルスＰ1 の発生タイミングを変化させればよい。

【００３９】（第４の実施の形態）この実施の形態は請求項６に対応した実施の形態について述べる。この実施の形態の駆動回路の構成は図９に示すように基本的には第１の実施の形態と同様で、異なる点は電源供給回路３２とプリントパルスＰＰを出力する印字データ変換回路３４である。すなわち、前記電源供給回路３２は印刷タイミング毎に波形の異なる各種の基準電圧波形を連続して出力するようになっている。例えば、三角波の基準電圧波形Ｔ1 及び定電圧期間の長さが異なる２種類の台形状の基準電圧波形Ｔ2 ，Ｔ3 の３種類を連続して出力するようになっている。各基準電圧波形はいずれも立ち上がりは滑らか、立下がりは急俊な波形になっている。

【００４０】前記印字データ変換回路３４は３種類の基準電圧波形Ｔ1 ，Ｔ2 ，Ｔ3 のいずれを各圧電部材１１１～１１６，…に印加させるかを選択するために各トランジスタ１３1 ～１３６，…をオン動作するプリントパルスＰＰを発生するようになっている。

【００４１】この駆動回路においては、印刷タイミングになると、図１０の(a) に示すように、プリントタイミングパルスＰＴＰを電源供給回路３２及び印字データ変換回路３４に供給し、これにより電源供給回路３２は図１０の(b) に示すような３種類の基準電圧波形Ｔ1 ，Ｔ2 ，Ｔ3 を連続的に出力する。また、駆動したい圧電部材１１ｉに対応したトランジスタ１３ｉのベースに、例えば、図１０の(c) に示すように基準電圧波形Ｔ3 を選択するためのプリントパルスＰＰを供給する。

【００４２】これにより、圧電部材１１ｉには図１０の(d) に示すような供給電圧波形が印加することになる。この供給電圧波形は圧電部材１１ｉの電荷を一定時間保持し、圧電部材１１ｉを所定の変位位置で一定時間保持する。そして、一定時間経過後に、圧電部材１１ｉの電荷を急激に放電して圧電部材１１ｉを定常状態に戻す。こうして、圧電部材１１ｉを所定の変位位置で一定時間保持する電圧波形を供給することでインク室から吐出するインク量は多くなる。すなわち、階調濃度の高い印刷となる。

【００４３】また、駆動したい圧電部材１１ｉに対応したトランジスタ１３ｉのベースに、例えば、図１０の(e) に示すように基準電圧波形Ｔ2 を選択するためのプ

リントパルスＰＰを供給する。これにより、圧電部材１１ｉには図１０の(f) に示すような供給電圧波形が印加することになる。この供給電圧波形は圧電部材１１ｉの電荷を図１０の(d) の波形のときよりも短いが一定時間保持し、圧電部材１１ｉを所定の変位位置で一定時間保持する。そして、一定時間経過後に、圧電部材１１ｉの電荷を急激に放電して圧電部材１１ｉを定常状態に戻す。こうして、圧電部材１１ｉを所定の変位位置で一定の短い時間保持する電圧波形を供給することでインク室から吐出するインク量は中程度になる。すなわち、階調濃度が中程度の印刷となる。

【００４４】また、駆動したい圧電部材１１ｉに対応したトランジスタ１３ｉのベースに、例えば、図１０の(g) に示すように基準電圧波形Ｔ１を選択するためのブリントパルスＰＰを供給する。これにより、圧電部材１１ｉには図１０の(h) に示すような供給電圧波形が印加することになる。この供給電圧波形は所定レベルに達すると圧電部材１１ｉの電荷をほとんど保持せずに直ちに放電して圧電部材１１ｉを定常状態に戻す。こうして、圧電部材１１ｉの電荷を保持せずに直ちに放電することでインク室から吐出するインク量は少なくなる。すなわち、階調濃度の低い印刷となる。このように、トランジスタ１３ｉのベースに印加するブリントパルスＰＰにより圧電部材１１ｉに供給する基準電圧波形を選択するという簡単な制御により、インク室から吐出するインク量を調整することができ、階調印刷ができる。

【００４５】（第５の実施の形態）この実施の形態は複数のインク室をその部屋間の仕切りを圧電部材で構成したシェアモード形の記録ヘッドに適用したもので、請求項１及び２に対応した実施の形態について述べる。シェアモード形の記録ヘッドは、図１４に示すように、凹状の溝を複数形成した圧電部材４１とこの圧電部材４１の上に別の圧電部材４２を張合わせ、この上に天板４３を張合わせて複数のインク室４４，４４，…を形成したもので、各インク室４４の内壁には無電解ニッケルメッキにより電極４５を形成している。前記各圧電部材４１，４２は、板厚方向で互いに対向する方向に分極している。

【００４６】このシェアモード形の記録ヘッドの駆動回路の構成は図１１に示すように、隣接した壁を構成する圧電部材４２１と４２２に接続した電極４５１を双方向スイッチ４６１を介して基準電圧波形ＢＶ１の供給ライン４７１に接続し、隣接した壁を構成する圧電部材４２２と４２３に接続した電極４５２を双方向スイッチ４６２を介して基準電圧波形ＢＶ２の供給ライン４７２に接続し、隣接した壁を構成する圧電部材４２３と４２４に接続した電極４５３を双方向スイッチ４６３を介して基準電圧波形ＢＶ３の供給ライン４７３に接続し、隣接した壁を構成する圧電部材４２４と４２５に接続した電極４５４を双方向スイッチ４６４を介して基準電圧波形ＢＶ１の供給ライン４７１に接続し、隣接した壁を構成する圧電部材４２５と４２６に接続した電極４５５を双方向スイッチ４６５を介して基準電圧波形ＢＶ２の供給ライン４７２に接続し、隣接した壁を構成する圧電部材４２６と４２７に接続した電極４５６を双方向スイッチ４６６を介して基準電圧波形ＢＶ３の供給ライン４７３に接続し、…という構成になっている。

【００４７】シェアモード形の記録ヘッドは、その構造上、隣接するインク室を同時に駆動することはできないので２分割駆動や３分割駆動の方式を取るが、上記駆動回路は３分割駆動を行うものである。前記各双方向スイッチ４６１，４６２，４６３，４６４，４６５，４６６，…はそれぞれ２本の制御信号Ａ1HとＡ1L，Ｂ1HとＢ1L，Ｃ1HとＣ1L，Ａ2HとＡ2L，Ｂ2HとＢ2L，Ｃ2HとＣ2L，…によってスイッチン制御し、この制御信号によりインク室の選択とインク吐出量の制御を行うようになっている。なお、図中Ａ１，Ｂ１，Ｃ１，Ａ２，Ｂ２，Ｃ２，…はそれぞれインク室を示している。

【００４８】この駆動回路は、各供給ライン４７１，４７２，４７３にそれぞれ基準電圧波形ＢＶ１，ＢＶ２，ＢＶ３を図１２の(a) 、(b) 、(c) に示すタイミングで供給する。今、供給ライン４７１に基準電圧波形ＢＶ１が供給するタイミングで図１２の(d) に示すように制御信号Ａ1Hをオンし、図１２の(e) に示すように制御信号Ａ1Lをオフし、図１２の(f) に示すように制御信号Ｂ1Hをオフし、図１２の(g) に示すように制御信号Ｂ1Lをオンすると、双方向スイッチ４６１，４６２を介して圧電部材４２１，４２２に基準電圧波形ＢＶ１が印加し、圧電部材４２１，４２２はインク室Ａ１を図１３の(a) の定常状態から図１３の(b) に示すように徐々に開く方向に変位する。

【００４９】そして、基準電圧波形ＢＶ１が立ち下がる直前に制御信号Ａ1Hをオフすると、圧電部材４２１，４２２は図１３の(c) に示すようにその変位状態を保持する。その後、制御信号Ａ1Lをオンに戻すが、この制御信号Ａ1Lをオンに戻すタイミングを変化させることでインク室Ａ１の電極４５１に供給する電圧波形が図１２の(j) に示すように変化する。すなわち、圧電部材４２１，４２２の電圧保持時間が変化する。そして、一定の保持時間が経過すると、制御信号Ａ1Lがオン状態に復帰し、圧電部材４２１，４２２の電荷を急俊に放電してこの圧電部材４２１，４２２を図１３の(d) に示すように定常状態に戻し、インク室Ａ１からインク吐出口を介してインクを吐出させる。

【００５０】こうして、制御信号Ａ1Lをオンに戻すタイミングを変化させることで圧電部材４２１，４２２の電圧保持時間が変化するので、前述した第１の実施の形態と同様にインク室Ａ１からのインクの吐出量を変化させることができ、階調印刷が可能になる。

【００５１】次に、供給ライン４７２に基準電圧波形Ｂ

Ｖ2 が供給するタイミングで図１２の(f) に示すように制御信号Ｂ1Hをオンし、図１２の(g) に示すように制御信号Ｂ1Lをオフし、図１２の(d) に示すように制御信号Ａ1Hをオフし、図１２の(e)に示すように制御信号Ａ1Lをオンし、図１２の(h) に示すように制御信号Ｃ1Hをオフし、図１２の(i) に示すように制御信号Ｃ1Lをオンすると、双方向スイッチ４６１，４６２，４６３を介して圧電部材４２２，４２３に基準電圧波形ＢＶ2が印加し、圧電部材４２２，４２３はインク室Ｂ1 を図１３の(e) の定常状態から図１３の(f) に示すように徐々に開く方向に変位する。

【００５２】そして、基準電圧波形ＢＶ2 が立ち下がる直前に制御信号Ｂ1Hをオフすると、圧電部材４２２，４２３はその変位状態を保持する。その後、制御信号Ｂ1Lをオンに戻すが、この制御信号Ｂ1Lをオンに戻すタイミングを変化させることでインク室Ｂ1 の電極４５２に供給する電圧波形が図１２の(k) に示すように変化する。すなわち、圧電部材４２２，４２３の電圧保持時間が変化する。そして、一定の保持時間が経過すると、制御信号Ｂ1Lがオン状態に復帰し、圧電部材４２２，４２３の電荷を急俊に放電してこの圧電部材４２２，４２３を定常状態に戻しインク室Ｂ1 からインク吐出口を介してインクを吐出させる。

【００５３】こうして、制御信号Ｂ1Lをオンに戻すタイミングを変化させることで圧電部材４２２，４２３の電圧保持時間が変化するので、前述した第１の実施の形態と同様にインク室Ｂ1 からのインクの吐出量を変化させることができ、階調印刷が可能になる。

【００５４】同様にして、供給ライン４７３に基準電圧波形ＢＶ3 が供給するタイミングで図１２の(h) に示すように制御信号Ｃ1Hをオンし、図１２の(i) に示すように制御信号Ｃ1Lをオフし、図１２の(d) に示すように制御信号Ａ1Hをオフし、図１２の(e) に示すように制御信号Ａ1Lをオンし、図１２の(f) に示すように制御信号Ｂ1Hをオフし、図１２の(g) に示すように制御信号Ｂ1Lをオンすると、双方向スイッチ４６２，４６３，４６４を介して圧電部材４２３，４２４に基準電圧波形ＢＶ3 が印加し、圧電部材４２３，４２４はインク室Ｃ1 を定常状態から徐々に開く方向に変位する。

【００５５】そして、基準電圧波形ＢＶ3 が立ち下がる直前に制御信号Ｃ1Hをオフすると、圧電部材４２３，４２４はその変位状態を保持する。その後、制御信号Ｃ1Lをオンに戻すが、この制御信号Ｃ1Lをオンに戻すタイミングを変化させることでインク室Ｃ1 の電極４５３に供給する電圧波形が図１２の(l) に示すように変化する。すなわち、圧電部材４２３，４２４の電圧保持時間が変化する。そして、一定の保持時間が経過すると、制御信号Ｃ1Lがオン状態に復帰し、圧電部材４２３，４２４の電荷を急俊に放電してこの圧電部材４２３，４２４を定常状態に戻しインク室Ｃ1 からインク吐出口を介してインクを吐出させる。

【００５６】こうして、制御信号Ｃ1Lをオンに戻すタイミングを変化させることで圧電部材４２３，４２４の電圧保持時間が変化するので、前述した第１の実施の形態と同様にインク室Ｃ1 からのインクの吐出量を変化させることができ、階調印刷が可能になる。

【００５７】このようにシェアモード形の記録ヘッドにおいて３分割駆動する場合は２つ置きのインク室が同時に動作可能となり、どのインク室を動作させるかは制御信号ＡiH，ＢiH，ＣiHのオンと制御信号ＡiL，ＢiL，ＣiLのオフによって決め、かつ、階調制御は制御信号ＡiL，ＢiL，ＣiLのオン復帰タイミングを変化させることで可能となる。なお、制御信号ＡiH，ＢiH，ＣiH，ＡiL，ＢiL，ＣiLの iは1,2,3,…を示す。

【００５８】（第６の実施の形態）この実施の形態はシェアモード形の記録ヘッドにおいてインク室を１つ置きに使用する場合について述べる。この駆動回路は図１５に示すように、隣接した壁を構成する圧電部材５１１と５２２に接続した電極５２１を基準電圧波形の供給ライン５４に接続し、隣接した壁を構成する圧電部材５１２と５１３に接続した電極５２２をＮＰＮ形トランジスタ５３１を介して接地し、隣接した壁を構成する圧電部材５１３と５１４に接続した電極５２３を前記供給ライン５４に接続し、隣接した壁を構成する圧電部材５１４と５１５に接続した電極５２４をＮＰＮ形トランジスタ５３２を介して接地し、隣接した壁を構成する圧電部材５１５と５１６に接続した電極５２５を前記供給ライン５４に接続し、隣接した壁を構成する圧電部材５１６と５１７に接続した電極５２６をＮＰＮ形トランジスタ５３３を介して接地し、…という構成になっている。そして、前記圧電部材５１２と５１３との間にインク室Ａ1を形成し、前記圧電部材５１４と５１５との間にインク室Ａ2 を形成し、前記圧電部材５１６と５１７との間にインク室Ａ3 を形成し、…というように１つ置きにインク室を形成し、その他はインクを充填しない単なる空間部になっている。この記録ヘッドの場合は１つ置きにインク室を形成しているので全てのインク室を同時に動作させることが可能である。また、各圧電部材５１１～５１７…を駆動するための供給ライン５４に供給する基準電圧波形及び各トランジスタ５３１，５３２，５３３をオン、オフ動作するプリントパルスＰＰのタイミングは前述した第１の実施の形態における図２の場合と同様である。

【００５９】すなわち、三角波の基準電圧波形を供給ライン５４に供給し、同時に各トランジスタ５３１，５３２，５３３にプリントパルスＰＰを供給してオン動作すると、各圧電部材５１２，５１３，５１４，５１５，５１６，５１７に基準電圧波形がそれぞれ印加し、圧電部材５１２と５１３はインク室Ａ1 を徐々に開くように変位し、圧電部材５１４と５１５はインク室Ａ2 を徐々に

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開くように変位し、圧電部材５１６と５１７はインク室Ａ３を徐々に開くように変位する。すなわち、インク室Ａ１，Ａ２，Ａ３は図１６の(a) の定常状態から図１６の(b) に示すように変化する。

【００６０】その後、基準電圧波形が立ち下がる直前で各トランジスタ５３１，５３２，５３３を一旦オフさせて各圧電部材５１２，５１３，５１４，５１５，５１６，５１７の変位状態を図１６の(c) に示すように保持させる。そして、この保持時間を適当に制御して各トランジスタ５３１，５３２，５３３を再度オン動作すると、各圧電部材５１２，５１３，５１４，５１５，５１６，５１７は急激に定常状態に戻る。すなわち、インク室Ａ１，Ａ２，Ａ３は図１６の(c) の状態から図１６の(d) の状態に変化し、各インク室Ａ１，Ａ２，Ａ３からインクが吐出する。このときの各インク室Ａ１，Ａ２，Ａ３からのインクの吐出量は、各圧電部材５１２，５１３，５１４，５１５，５１６，５１７の変位状態を保持する時間の長さを調整することで制御でき、これにより階調印刷が可能になる。その後、各インク室Ａ１，Ａ２，Ａ３は図１６の(e) に示す定常状態で待機し、次の印刷タイミングに備えるようになる。

【００６１】このように、シェアモード形の記録ヘッドにおいてインク室を１つ置きに使用する場合は、隣合う空間部はインク室と使用しないので、例えば、この記録ヘッドで３００ｄｐｉの印刷を行う場合、記録ヘッドとしては６００ｄｐｉのものが必要となる。

【００６２】なお、前述した第５、第６の実施の形態は、圧電部材が変位した状態での保持時間を可変することによって階調制御する場合について述べたが、このようなシェアモード形の記録ヘッドにおいても前述したカイザー方式の記録ヘッドと同様に、圧電部材が変位した状態での保持電圧レベルを可変することによって階調制御することも、保持時間と保持電圧レベルの両方を可変して階調制御することもできる。

【００６３】

【発明の効果】以上、請求項１乃至６記載の発明によれば、圧電部材に電圧を印加してこの圧電部材を変位させ、この圧電部材の変位によりインク室を変形させてこのインク室内のインクを吐出し印刷を行う記録ヘッドにおいて、簡単な制御でインク室からのインクの吐出量を可変制御でき、階調印刷ができる。

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＊【図面の簡単な説明】

【図１】本発明の第１の実施の形態を示す記録ヘッド駆動回路の回路構成図。

【図２】同実施の形態における動作タイミングを示すパルス波形及び電圧波形図。

【図３】同実施の形態における印刷原理を説明するための模式図。

【図４】同実施の形態で使用する記録ヘッドの一例を示す断面図。

【図５】本発明の第２の実施の形態における動作タイミングを示すパルス波形及び電圧波形図。

【図６】同実施の形態における印刷原理を説明するための模式図。

【図７】本発明の第３の実施の形態における動作タイミングを示すパルス波形及び電圧波形図。

【図８】同実施の形態における印刷原理を説明するための模式図。

【図９】本発明の第４の実施の形態を示す記録ヘッド駆動回路の回路構成図。

【図１０】同実施の形態における動作タイミングを示すパルス波形及び電圧波形図。

【図１１】本発明の第５の実施の形態を示す記録ヘッド駆動回路の回路構成図。

【図１２】同実施の形態における動作タイミングを示す制御信号波形及び電圧波形図。

【図１３】同実施の形態における印刷原理を説明するための模式図。

【図１４】同実施の形態における記録ヘッドの構成を示す部分断面図。

【図１５】本発明の第６の実施の形態を示す記録ヘッド駆動回路の回路構成図。

【図１６】同実施の形態における印刷原理を説明するための模式図。

【図１７】従来例を示す記録ヘッド駆動回路の回路構成図。

【符号の説明】

１１１～１１６，１１ｉ，２３…圧電部材

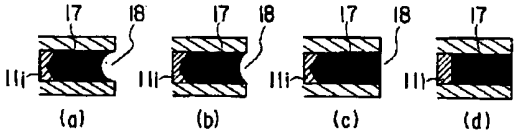
１２…電源供給回路

１３１～１３６，１３ｉ…ＮＰＮ形トランジスタ

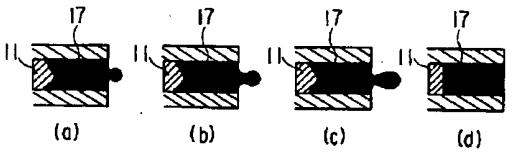
１４…印字データ変換回路

１７，２１…インク室

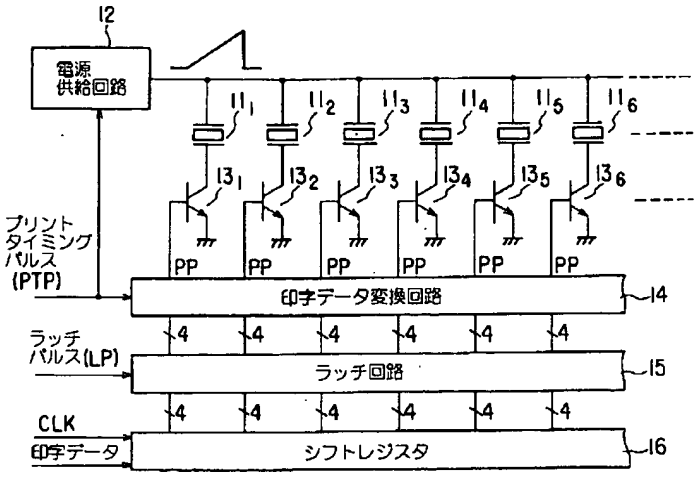
【図３】



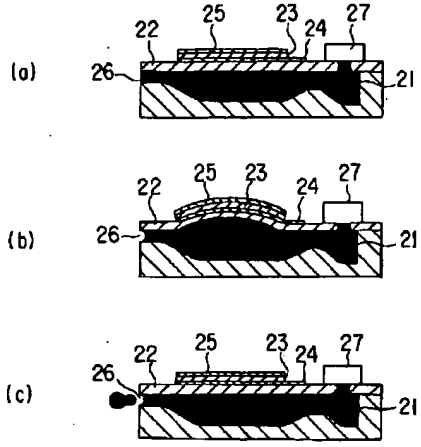
【図６】



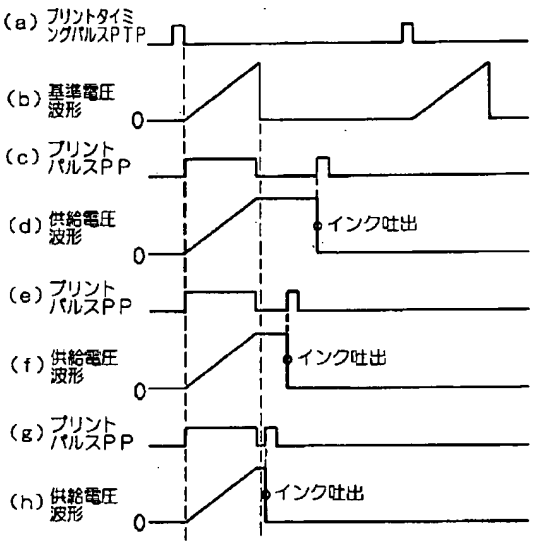
【図１】



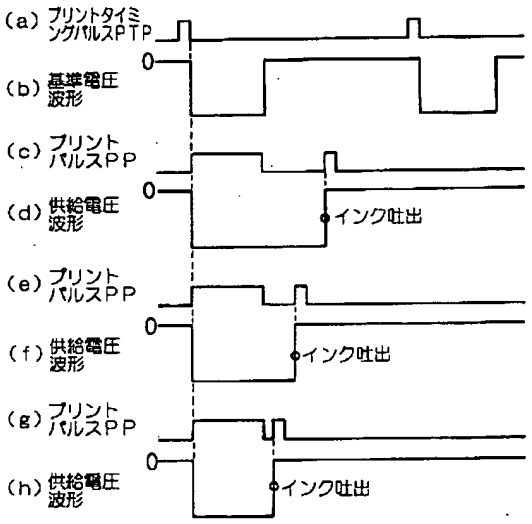
【図４】



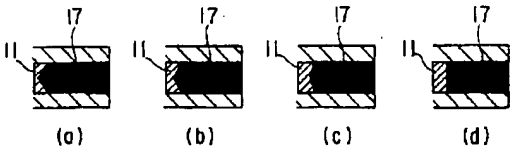
【図２】



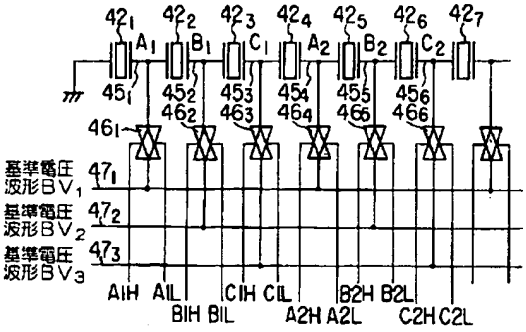
【図５】



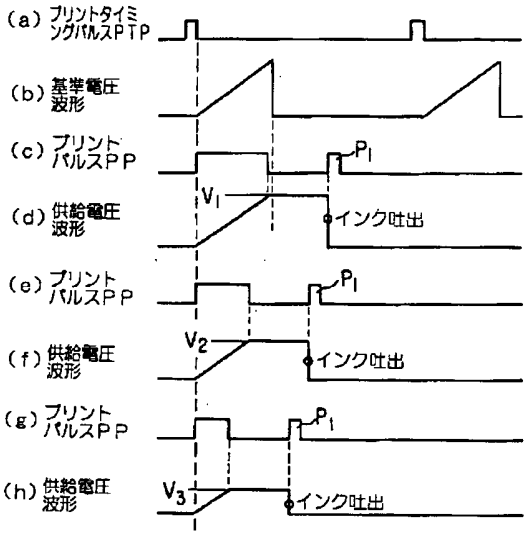
【図８】



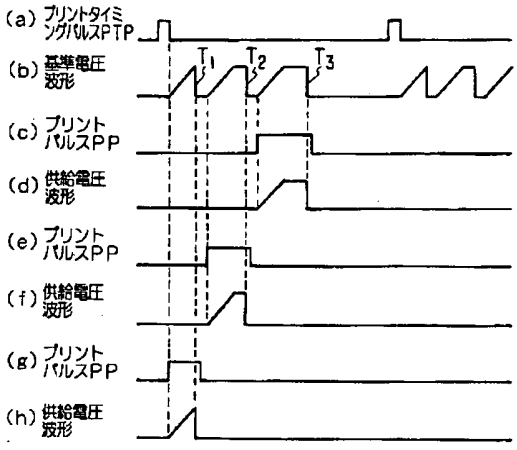
【図１１】



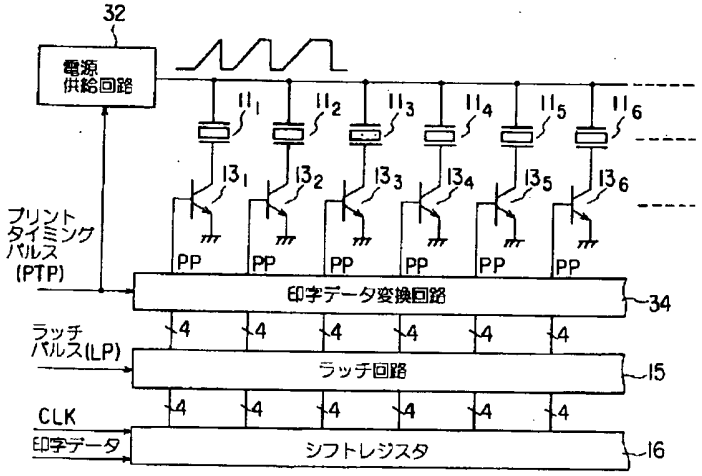
【図7】



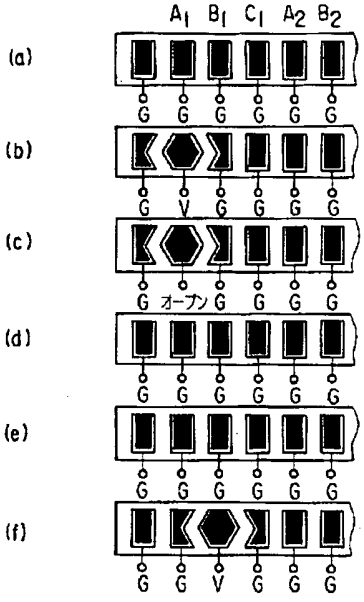
【図10】



【図9】



【図13】



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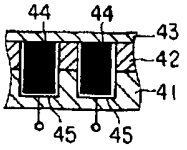

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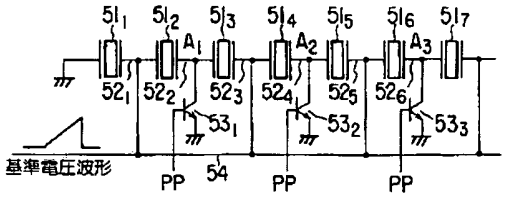

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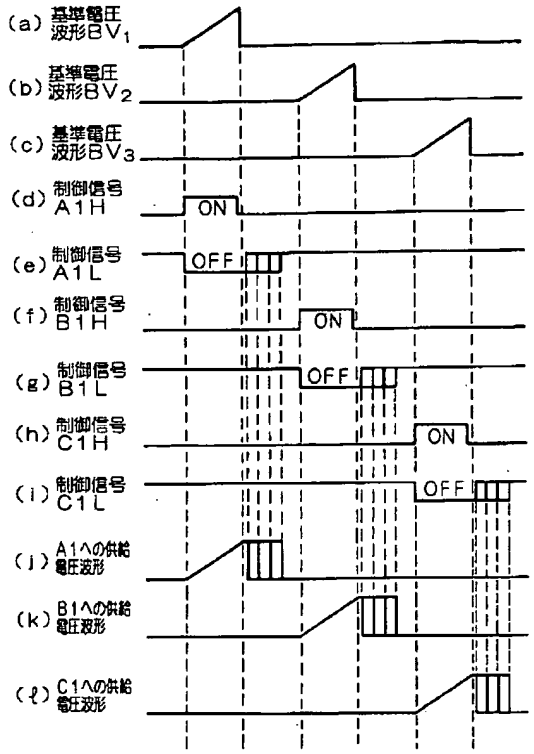

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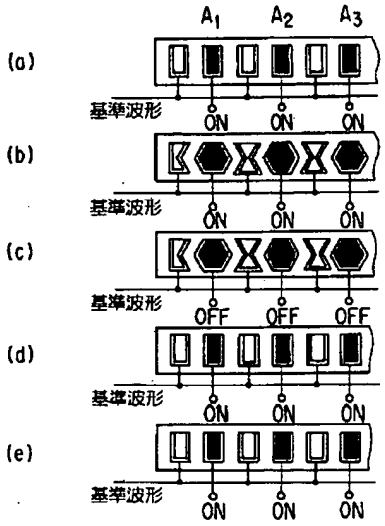
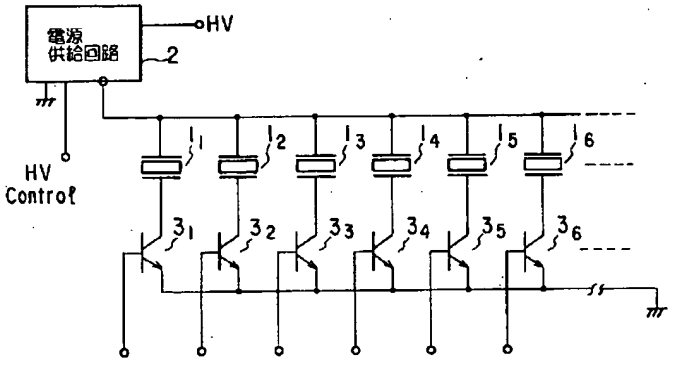


【図１７】



フロントページの続き

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